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(71)Applicant : ALPS ELECTRIC CO LTD
(72)Inventor : HASEGAWA NAOYA

## (54) MAGNETIC DETECTING ELEMENT

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a CPP type magnetic detecting element in which the occurrence of side reading can be suppressed appropriately by suppressing the spread of an effective reproduction track width.
SOLUTION: A side shield layer 35 is provided between a lower shield layer 20 and an upper shield layer 37 on that are both sides of a multilayer film 33 in the track width direction. Since the spread of an effective reproduction track width is suppressed even if the track is made narrower, a magnetic detecting element in which the occurrence of side reading can be suppressed as compared with a prior art can be manufactured.

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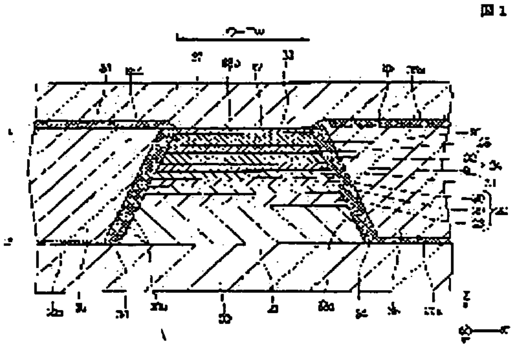

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CLAIMS

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[Claim(s)]
[Claim 1] In the magnetic sensing element to which the multilayers which have an antiferromagnetism layer, a fixed magnetic layer, a non-magnetic material layer, and a free magnetic layer are prepared, and a current flows to the film surface and perpendicular direction of each class of said multilayers The lower shielding layer formed crosswise [ truck ] by extending rather than the both-sides end face of the truck cross direction of said multilayers is prepared in said multilayers bottom. To said multilayers up side The up shielding layer formed crosswise [ truck ] by extending rather than the both-sides end face of the truck cross direction of said multilayers is prepared. The magnetic sensing element which are the both sides of the truck cross direction of said multilayers, and is characterized by preparing the side shielding layer between said lower shielding layer and an up shielding layer.
[Claim 2] Said side shielding layer and magnetic sensing element according to claim 1 by which the insulating layer is prepared between the both-sides end faces of the truck cross direction of multilayers.
[Claim 3] The thickness in the truck cross direction of said insulating layer is a magnetic sensing element according to claim 2 which is 0.06 micrometers or less in 0.003 micrometers or more.
[Claim 4] The thickness in the truck cross direction of said insulating layer is a magnetic sensing element according to claim 2 which is 0.03 micrometers or less in 0.003 micrometers or more.
[Claim 5] Said side shielding layer is a magnetic sensing element according to claim 1 to 4 which is formed by the monolayer or multilayer structure formed with the magnetic material, and is formed with the magnetic material which has resistivity higher than said fixed magnetic layer and free magnetic layer.
[Claim 6] Said side shielding layer is a magnetic sensing element according to claim 1 to 5 which is formed by the monolayer or multilayer structure formed with the magnetic material, and is formed with a different magnetic material from an up shielding layer and/or a lower shielding layer.
[Claim 7] Said side shielding layer is a magnetic sensing element according to claim 5 or 6 in which at least one layer which constitutes it is formed with Co system amorphous material.
[Claim 8] For an empirical formula, at least one layer which constitutes it is [ said side shielding layer ] the magnetic sensing element according to claim 5 or 6 in which it is formed with the magnetic material which consists of Fe-M-O (however, one sort or two sorts or more of elements with which Element M is chosen from Ti, Zr, Hf, Nb, Ta, Cr, Mo, Si, P, C, W, B, aluminum, Ga, germanium, and rare earth elements).
[Claim 9] Said side shielding layer is a magnetic sensing element according to claim 1 to 4 which is the switched connection film formed by the laminated structure of an antiferromagnetism layer and a soft magnetism layer.
[Claim 10] Said up shielding layer is a magnetic sensing element according to claim 1 to 9 formed in contact with the top face of said multilayers.
[Claim 11] The magnetic sensing element according to claim 10 to which an insulating layer intervenes between said up shielding layer and a side shielding layer.
[Claim 12] Said lower shielding layer is a magnetic sensing element according to claim 1 to 11 formed in contact with the inferior surface of tongue of said multilayers.
[Claim 13] The magnetic sensing element according to claim 12 to which an insulating layer intervenes between said lower shielding layer and a side shielding layer.
[Claim 14] Said side shielding layer is a magnetic sensing element according to claim 1 to 5 currently formed in either an up shielding layer or a lower shielding layer and one.
[Claim 15] The magnetic sensing element according to claim 14 to which the magnetic field formed with Co system amorphous material exists in said side shielding layer and up shielding layer or side shielding layer formed in one, and a lower shielding layer.
[Claim 16] In said side shielding layer and up shielding layer or side shielding layer formed in one, and a lower shielding layer An empirical formula is Fe-M-O (however, Element M). The magnetic sensing element according to claim 5 or 6 in which the magnetic field formed with the magnetic material which consists of one sort or two sorts or more of elements chosen from Ti, Zr, Hf, Nb, Ta, Cr, Mo, Si, P, C, W, B, aluminum, Ga, germanium, and

rare earth elements exists.
[Claim 17] Said up shielding layer is a magnetic sensing element according to claim 14 to 16 formed in contact with the top face of said multilayers.
[Claim 18] Said lower shielding layer is a magnetic sensing element according to claim 14 to 17 formed in contact with the inferior surface of tongue of said multilayers.
[Claim 19] The magnetic sensing element according to claim 1 to 18 by which a bias layer is prepared in the reverse side side of the field which touches the non-magnetic material layer of said free magnetic layer through a non-magnetic layer.
[Claim 20] Said non-magnetic material layer is a magnetic sensing element according to claim 1 to 19 formed with a nonmagnetic electrical conducting material.
[Claim 21] Said non-magnetic material layer is a magnetic sensing element according to claim 1 to 19 formed by the insulating material.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention can relate to the magnetic sensing element of a CPP (current perpendicular to the plane) mold, especially can stop effective regenerative-track broadening also in narrow-track-izing, and relates to the magnetic sensing element which can control generating of side leading compared with the former.
[0002]
[Description of the Prior Art] Drawing 16 is the fragmentary sectional view which looked at the structure of the magnetic sensing element in the former from the opposed face side with a record medium.
[0003] The sign 1 shown in drawing 16 is a lower electrode layer, and the multilayers 6 which consist of the antiferromagnetism layer 2, the fixed magnetic layer 3, a non-magnetic material layer 4, and a free magnetic layer 5 are formed in the center of a top face of said lower electrode layer 1 from the bottom. As shown in drawing 16 , optical width-of-recording-track O-Tw is determined by the width method of the truck cross direction (the direction of illustration X) of the top face of said multilayers 6.
[0004] As shown in drawing 16 , it is the both sides of the truck cross direction (the direction of illustration X) of said multilayers 6, and the insulating layer 7 is formed on said lower electrode layer 1. Said insulating layers 7 are aluminum 2O3, SiO2, etc.
[0005] As shown in drawing 16 , the up electrode layer 8 is formed on said insulating layer 7 and multilayers 6.
[0006] The electrode layers 1 and 8 are formed up and down, and the magnetic sensing element shown in drawing 16 is the structure where the sense current from said electrode layers 1 and 8 is called the CPP (current perpendicular to the plane) mold of multilayers 6 which flows from a perpendicular direction to the film surface of each class of multilayers 6.
[0007] Said CPP type of magnetic sensing element has structure which can be appropriately dealt with the further future high recording density-ization -- improvement in a playback output can be aimed at also in narrow-track-izing compared with the magnetic sensing element of the CIP (current in the plane) mold which passes a sense current from a direction parallel to the film surface of said multilayers 6.
[0008]
[Problem(s) to be Solved by the Invention] By the way, the following troubles have made it remarkable as narrow track-ization is increasingly promoted with the latest raise in recording density.
[0009] Namely, when reading the record field which the magnetic head which has a magnetic sensing element is surfaced on a record medium, and is generated from a certain recording track, The recording track with which said magnetic sensing element adjoins said recording track Even if there is nothing in the location which countered upwards, if it is a location near said adjoining truck in distance, a certain forge fire, (It is hereafter called an adjoining truck) The leakage field (leakage field especially generated near the both sides of the truck cross direction of said multilayers 6) from the adjoining truck which spreads in three dimensions becomes easy to invade into a magnetic sensing element, and it becomes easy to produce the phenomenon in which it is sensed in the field near the both-sides section of multilayers 6.
[0010] Although it was not a problem so much when this phenomenon had large optical width-of-recording-track O-Tw and track pitch spacing of a magnetic sensing element If especially optical width-of-recording-track O-Tw is set to 0.2 micrometers or less, track pitch spacing will also become narrow. The rate of the magnitude of the leakage field which invades from said adjoining truck to the magnitude of the field from the recording track for detection becomes large. Consequently, the phenomenon in which an effective regenerative-track width method will become larger than optical width-of-recording-track O-Tw arose, the fault of side leading was generated and the problem of it becoming impossible for a magnetic sensing element to correspond to high recording density-ization of a record medium appropriately had arisen.
[0011] Then, this invention is for solving the above-mentioned conventional technical problem, and in the magnetic sensing element of a CPP mold, effective regenerative-track broadening is stopped also especially in narrow-track-

izing, and it aims at offering the magnetic sensing element which can control generating of side leading appropriately.
[0012]
[Means for Solving the Problem] In the magnetic sensing element to which the multilayers in which this invention has an antiferromagnetism layer, a fixed magnetic layer, a non-magnetic material layer, and a free magnetic layer are prepared, and a current flows to the film surface and perpendicular direction of each class of said multilayers The lower shielding layer formed crosswise [ truck ] by extending rather than the both-sides end face of the truck cross direction of said multilayers is prepared in said multilayers bottom. To said multilayers up side The up shielding layer formed crosswise [ truck ] by extending rather than the both-sides end face of the truck cross direction of said multilayers is prepared. It is the both sides of the truck cross direction of said multilayers, and is characterized by preparing the side shielding layer between said lower shielding layer and an up shielding layer.
[0013] By this invention, the upper and lower sides and both-sides right and left of said multilayers can be made into the structure mostly surrounded in said shielding layer as mentioned above by preparing the layer which should serve as shielding not only in said multilayers bottom (lower shielding layer) and top (up shielding layer) but in the both sides of the truck cross direction of said multilayers. And it becomes possible to be able to absorb appropriately the leakage field from the adjoining truck which became a problem conventionally by promotion of narrow-track-izing in said side shielding layer, to be able to stop effective regenerative-track broadening compared with the former also in narrow-track-izing, and to control generating of side leading effectively by making it such structure.
[0014] Moreover, it is desirable that the insulating layer is prepared in this invention between the both-sides end faces of the truck cross direction of said side shielding layer and multilayers. In the magnetic sensing element of the CPP mold which passes [ of multilayers ] a current from the upper and lower sides like this invention, if the both-sides end face and side shielding layer in the truck cross direction of said multilayers have touched directly, said current may carry out splitting to said side shielding layer from said multilayers. Splitting of said current is not desirable in order to cause the fall of a playback output.
[0015] When especially the above-mentioned problem is the tunnel mold magneto-resistive effect mold component in which the non-magnetic material layer which constitutes said multilayers was formed by the insulating material, that it is hard to flow between a fixed magnetic layer and a free magnetic layer through a non-magnetic material layer, it is easy to shunt toward a side shielding layer, the current which flows the inside of said multilayers to a film surface perpendicular direction becomes it, and a playback output tends to decline greatly. Therefore, an insulating layer is made to intervene between the both-sides end faces of said side shielding layer and multilayers, and the inside of said multilayers was made for a current to flow appropriately in this invention.
[0016] As for thickness [ in / at this invention / the truck cross direction of said insulating layer ], it is desirable that it is 0.06 micrometers or less in 0.003 micrometers or more. According to the experiment mentioned later, it becomes possible to be able to hold down the value which lengthened optical width-of-recording-track O-Tw from effective regenerative-track width of face (it is also called magnetic regenerative-track width of face) to 0.015 micrometers or less, to be able to attain narrow-ization of effective regenerative-track width of face effectively also in narrow-track-izing, and to control generating of side leading by setting thickness in the truck cross direction of said insulating layer to 0.06 micrometers or less.
[0017] Moreover, as for thickness [ in / at this invention / the truck cross direction of said insulating layer ], it is more desirable that it is 0.03 micrometers or less in 0.003 micrometers or more. According to the experiment mentioned later, the value which lengthened optical width-of-recording-track O-Tw from effective regenerative-track width of face can be held down to 0.01 micrometers or less by setting thickness in the truck cross direction of said insulating layer to 0.03 micrometers or less.
[0018] Moreover, it is desirable for said side shielding layer to be formed at this invention by the monolayer or multilayer structure formed with the magnetic material, and to be formed with the magnetic material which has resistivity higher than said fixed magnetic layer and free magnetic layer. When the side shielding layer is formed directly in contact with the both-sides end face of multilayers especially by this, a current can control effectively flowing through a non-magnetic material layer and carrying out splitting of between a fixed magnetic layer and a free magnetic layer to said side shielding layer appropriately, and it becomes possible to aim at improvement in a playback output.
[0019] Moreover, it is desirable for said side shielding layer to be formed at this invention by the monolayer or multilayer structure formed with the magnetic material, and to be formed with a different magnetic material from an up shielding layer and/or a lower shielding layer. In this invention, it dissociates with an up shielding layer and a lower shielding layer, and said side shielding layer may be formed. In this invention, it becomes possible to form said side shielding layer with a magnetic material different from said up shielding layer and a lower shielding layer. The selectivity of the quality of the material of said side shielding layer can be extended by this, and it becomes possible to use the magnetic material which has resistivity higher than said lower shielding layer and an up

shielding layer in said side shielding layer.
[0020] For example, as for said side shielding layer, it is desirable that at least one layer which constitutes it is formed with Co system amorphous material.
[0021] Moreover, as for said side shielding layer, it is desirable that at least one layer which constitutes it is formed with the magnetic material with which an empirical formula consists of Fe-M-O (however, one sort or two sorts or more of elements with which Element M is chosen from Ti, Zr, Hf, Nb, Ta, Cr, Mo, Si, P, C, W, B, aluminum, Ga, germanium, and rare earth elements).
[0022] The above-mentioned Co system amorphous material and the Fe-M-O ingredient have high resistivity compared with the quality of the materials (permalloy etc.) generally used for a lower shielding layer or an up shielding layer. Said Co system amorphous material and Fe-M-O ingredient are formed by a spatter etc. On the other hand, although it is formed by the permalloy (NiFe alloy) in which plating formation is possible since a lower shielding layer and an up shielding layer need to be formed by very thick thickness, thickness is thin and, as for said side shielding layer, it enables it to form therefore with the quality of the material in which spatter formation is possible besides plating to use Co system amorphous material which became possible, for example, was described above compared with said lower shielding layer or an up shielding layer.
[0023] Moreover, in this invention, said side shielding layer may be the switched connection film formed by the laminated structure of an antiferromagnetism layer and a soft magnetism layer. In this case, if a switched connection field is not much strong, since it cannot function as shielding, a switched connection field has the need of weakening moderately.
[0024] Moreover, as for said up shielding layer, in this invention, it is desirable to be formed in contact with the top face of said multilayers. It is the configuration in which this, i.e., said up shielding layer, has an up electrode. In this case, it is desirable that an insulating layer intervenes between said up shielding layer and a side shielding layer. The current which flows from said up shielding layer to said multilayers by this does not carry out splitting to said side shielding layer from said up shielding layer, but it becomes possible to aim at improvement in a playback output appropriately.
[0025] Moreover, as for said lower shielding layer, in this invention, it is desirable to be formed in contact with the inferior surface of tongue of said multilayers. It is the configuration in which this, i.e., said lower shielding layer, has a lower electrode. In this case, it is desirable that an insulating layer intervenes between said lower shielding layer and a side shielding layer. The current which flows from said lower shielding layer to said multilayers by this does not carry out splitting to said side shielding layer from said lower shielding layer, but it becomes possible to aim at improvement in a playback output appropriately.
[0026] In addition, the need of insulating does not not necessarily have both vertical side that, as for the side shielding layer, either the top face (between up shielding layers) or an inferior surface of tongue (between lower shielding layers) should just be insulated.
[0027] It is effective when gap length Gl determined spacing between said shielding layers can be shortened by forming a lower shielding layer and/or an up shielding layer in contact with multilayers as described above, and attaining future high recording density-ization. And if said lower shielding layer and an up shielding layer are used as an electrode layer like [ it is not necessary to prepare an electrode layer separately from a shielding layer like before and, and ] this invention The upper and lower sides and both-sides right and left of said multilayers can be carried out to the configuration mostly surrounded in a shielding layer, without keeping away from said multilayers in distance, the leakage field from an adjoining truck can be more appropriately absorbed in said shielding layer, and it becomes possible to control effective regenerative-track broadening more effectively.
[0028] Moreover, said side shielding layer may be formed in either an up shielding layer or a lower shielding layer and one in this invention.
[0029] Moreover, in this invention, the magnetic field formed with Co system amorphous material may exist in said side shielding layer and up shielding layer or side shielding layer formed in one, and a lower shielding layer.
[0030] Moreover, in this invention, the magnetic field formed with the magnetic material with which an empirical formula consists of Fe-M-O (however, one sort or two sorts or more of elements with which Element M is chosen from Ti, Zr, Hf, Nb, Ta, Cr, Mo, Si, P, C, W, B, aluminum, Ga, germanium, and rare earth elements) may exist in said side shielding layer and up shielding layer or side shielding layer formed in one, and a lower shielding layer.
[0031] Moreover, as for said up shielding layer, in this invention, it is desirable to be formed in contact with the top face of said multilayers.
[0032] Moreover, as for said lower shielding layer, in this invention, it is desirable to be formed in contact with the inferior surface of tongue of said multilayers.
[0033] Moreover, it is desirable that a bias layer is prepared in the reverse side side of the field which touches the non-magnetic material layer of said free magnetic layer through a non-magnetic layer in this invention. The method using such a bias layer is called an in stack bias (instack bias) method. This in stack bias method can be effectively used to the magnetic sensing element of a CPP mold. If the above-mentioned in stack bias method is used for the

magnetic sensing element of the CIP mold which passes a sense current from a direction parallel to the film surface of multilayers temporarily, said sense current causes [ shunt toward said bias layer and ] the fall of a playback output and is not desirable. On the other hand, in passing a current from the film surface and perpendicular direction of multilayers like a CPP mold, said in stack bias method does not have a fear of not becoming but a playback output declining, as for the splitting path of a current. The above-mentioned in stack bias method is especially a CPP mold, and is such an effective bias method that it will be carried out if narrow track-ization is promoted.

[0034] In addition, by this invention, said non-magnetic material layer may be formed with a nonmagnetic electrical conducting material, or may be formed by the insulating material.

[0035]

[Embodiment of the Invention] Drawing 1 is the sectional view which saw the magnetic sensing element of the gestalt of operation of the 1st of this invention from the opposed face side with a record medium. In addition, drawing 1 fractures and shows only the central part of the component prolonged in the direction of X.

[0036] The magnetic sensing element (MR head) shown in drawing 1 is for reproducing the external signal recorded on the record medium. Moreover, in this invention, the laminating of the inductive head for record may be carried out on said magnetic sensing element.

[0037] Moreover, said magnetic sensing element is formed on the trailing end face of the slider formed for example, with alumina-titanium carbide (aluminum2O3-TiC). Said slider is joined to the supporter material by stainless steel material etc. in which elastic deformation is possible by the opposed face [ with a record medium ], and reverse side side, and magnetic-head equipment is constituted.

[0038] The sign 20 shown in drawing 1 is a lower shielding layer. Said lower shielding layer 20 serves as the lower electrode with this operation gestalt. Said lower shielding layer 20 is formed with a magnetic material. As the quality of the material, a NiFe alloy (permalloy), Fe-aluminum-Si (Sendust), etc. are used, and these quality of the materials are formed of plating or sputtering. Properties required as said shielding layer are high permeability, a low magnetostriction constant, etc.

[0039] As shown in drawing 1 , in the center of a top face in the direction of illustration X of said lower shielding layer 20, laminating formation of the antiferromagnetism layer 21, the fixed magnetic layer 22, the non-magnetic material layer 23, the free magnetic layer 24 and a non-magnetic layer 25, the bias layer 26, and the protective layer 27 is carried out in this order from the bottom.

[0040] In addition, the substrate layer (not shown) formed between said antiferromagnetism layer 21 and said lower shielding layer 20 by at least one or more sorts in Ta, Hf, Nb, Zr, Ti, Mo, and W may be prepared. Moreover, between said substrate layers and antiferromagnetism layers 21 or between said antiferromagnetism layer 21 and the lower shielding layer 20, the seed layer (not shown) formed by Cr, NiFeCr, etc. may be prepared. By forming said seed layer, the diameter of crystal grain in a direction parallel to the film surface of each class formed on said seed layer can be enlarged, and improvement in energization dependability, improvement in resistance rate of change (deltaR/R), etc. which are represented by improvement in electromigration-proof can be aimed at more appropriately.

[0041] As for the antiferromagnetism layer 21 formed on said lower shielding layer 20 shown in drawing 1 , it is desirable to be formed with the antiferromagnetism ingredient containing Elements X (however, for X to be one sort or two sorts or more of elements among Pt, Pd, Ir, Rh, Ru, and Os) and Mn. Or said antiferromagnetism layer 21 is Element X and element X' (however, element X'). Ne, Ar, Kr, Xe, Be, B, C, N, Mg, aluminum, Si, P, Ti, V, Cr, Fe, Co, nickel, Cu, Zn, Ga, germanium, Zr, Nb, Mo, Ag, Cd, Sn, Hf, Ta, W, Re, Au, Pb, and the inside of rare earth elements -- one sort or two sorts or more of elements -- it is -- being formed with the antiferromagnetism ingredient containing Mn is desirable.

[0042] These antiferromagnetism ingredients may generate a big exchange anisotropy field in an interface with the magnetic layer 28 which constitutes the fixed magnetic layer 22 which is excellent in corrosion resistance, and blocking temperature is also high and is moreover explained below. Moreover, as for said antiferromagnetism layer 21, it is desirable to be formed by thickness 300A or less by 80A or more.

[0043] Next, the fixed magnetic layer 22 formed on said antiferromagnetism layer 21 is formed by the three-tiered structure with this operation gestalt.

[0044] The layer of the signs 28 and 30 which constitute said fixed magnetic layer 22 is a magnetic layer, the nonmagnetic interlayer 29 formed by Ru etc. between the magnetic layer 28 and the magnetic layer 30 intervenes, and this configuration changes mutually the magnetization direction of said magnetic layer 28 and magnetic layer 30 into an anti-parallel condition. This is called the so-called laminating ferry structure. Said nonmagnetic interlayer 29 is formed among Ru, Rh, Ir, Cr, Re, and Cu with one sort or these two sorts or more of alloys. As for said especially nonmagnetic interlayer 29, being formed of Ru is desirable.

[0045] When an exchange anisotropy field occurs by heat treatment among a magnetic field between the magnetic layers 28 which touch said antiferromagnetism layer 21 of said antiferromagnetism layer 21 and said fixed

magnetic layer 22, for example, magnetization of said magnetic layer 28 is fixed in the height direction (the direction of illustration Y), the height direction is magnetized by hard flow (the direction of illustration Y, and hard flow), and another magnetic layer 30 is fixed by the RKKY interaction. The exchange anisotropy field which changes into the condition that magnetization of said fixed magnetic layer 22 was stabilized by this configuration, and is generated between said fixed magnetic layer 22 whole and said antiferromagnetism layers 21 can be enlarged seemingly.
[0046] In addition, for example, the thickness of about 10-70A and the nonmagnetic interlayer 29 is formed for the thickness of said magnetic layers 28 and 30 by formation by 3A - about 10A.
[0047] Moreover, as for said magnetic layer 28 and magnetic layer 30, the magnetic moments per unit area differ, respectively. It is possible to make said magnetic layer 28 and magnetic layer 30 into laminating ferry structure appropriately by said magnetic moment being set up by the saturation magnetization Msx thickness t, and changing the magnetic moment of said magnetic layer 28 and magnetic layer 30.
[0048] The non-magnetic material layer 23 is formed on said magnetic layer 30. Said non-magnetic material layer 23 is formed with a conductive ingredient with low electric resistance, such as Cu. Said non-magnetic material layer 23 is formed by about 25A thickness.
[0049] When said non-magnetic material layer 23 is formed with nonmagnetic electrical conducting materials, such as Cu, the magnetic sensing element of drawing 1 turns into a spin bulb GMR mold magneto-resistive effect component (CPP-GMR) of a CPP mold. Or said non-magnetic material layer 23 may be formed by insulating materials, such as aluminum 2O3 and SiO2. The magnetic sensing element in which said non-magnetic material layer 23 was formed by the insulating material turns into a spin bulb tunnel mold magneto-resistive effect mold component (CPP-TMR) using the tunnel MR effectiveness (the TMR effectiveness).
[0050] Next, the free magnetic layer 24 is formed on said non-magnetic material layer 23. In this operation gestalt, said free magnetic layer 24 is formed with the two-layer structure of a magnetic layer. Moreover, as for the thickness of said whole free magnetic layer 24, it is desirable to be formed by the thickness of 100A or less extent by 20A or more.
[0051] As for the magnetic layers 31 and 32 which constitute said free magnetic layer 24, it is desirable that it is one one sort of a CoFe alloy, a CoFeNi alloy, a NiFe alloy, and Co. It is more desirable that a magnetic layer 31 is formed with a CoFe alloy, and a magnetic layer 32 is formed with a NiFe alloy. Said magnetic layer 31 is a diffusion prevention layer for preventing diffusion of an element between said free magnetic layers 24 and non-magnetic material layers 23, and further improvement in resistance rate of change (deltaR/R) can be aimed at by forming the magnetic layer 31 which consists of a CoFe alloy.
[0052] As for the non-magnetic layer 25 prepared on said free magnetic layer 24 shown in drawing 1 , being formed with a nonmagnetic electrical conducting material is desirable. Specifically, it is desirable to be formed with one sort or two sorts or more of alloys among Ru, Rh, Ir, Cr, Re, and Cu. In addition, although said non-magnetic layer 25 may be formed by insulating materials, such as aluminum 2O3 and SiO2, in this case, it needs to form said non-magnetic layer 25 thinly, and for the current which flows between said up shielding layer and the lower shielding layer 20 to be made not to be intercepted in the part of said non-magnetic layer 25. As for the thickness of said non-magnetic layer 25, being formed by 20-100A is desirable.
[0053] And on said non-magnetic layer 25, the bias layer 26 made from a permanent magnet (in this case, it is called a hard bias layer) is formed. Said bias layer 26 is formed with a CoPtCr alloy, a CoPt alloy, etc. Said bias layer 26 may be switched connection film which becomes others from a soft magnetism layer and an antiferromagnetism layer.
[0054] With this operation gestalt, a vertical bias field is supplied towards said free magnetic layer 24 from the both-sides edge of the bias layer 26 (when the bias layer 26 consists of above-mentioned switched connection film, it is a soft magnetism layer) formed through the non-magnetic layer 25 on said free magnetic layer 24 (an arrow head shows), and magnetization of said free magnetic layer 24 is turned in the direction of illustration X.
[0055] The protective layer 27 formed on said bias layer 26 shown in drawing 1 is formed by non-magnetic materials, such as Ta.
[0056] In addition, on these specifications, the layered product which consisted of each class from the antiferromagnetism layer 21 shown in drawing 1 to a protective layer 27 is called multilayers 33.
[0057] With the operation gestalt shown in drawing 1 , rather than both-sides end-face 33a of the truck cross direction (the direction of illustration X) of said multilayers 33, it applies to said both-sides end-face 33a of said multilayers 33 from top-face 20a of the lower shielding layer 20 which extended crosswise [ truck ] (the direction of illustration X) further, and the insulating layer 34 is formed. Said insulating layer 34 consists of insulating materials, such as aluminum 2O3 and SiO2, and spatter membrane formation is carried out.
[0058] And the side shielding layer 35 is formed on said insulating layer 34. Said side shielding layer 35 consists of a magnetic material. About the quality of the material or a film configuration, it mentions later.
[0059] As shown in drawing 1 , the insulating layer 36 is formed on said side shielding layer 35. Said insulating

layer 36 consists of insulating materials, such as aluminum 2O3 and SiO2, and spatter membrane formation is carried out.

[0060] As shown in drawing 1 , it applies from on said insulating layer 36 on the protective layer 27 which is the maximum upper layer of said multilayers 33, and the up shielding layer 37 is formed. Said up shielding layer 37 also has the role of an up electrode with this operation gestalt. Said up shielding layer 37 is formed with a magnetic material. Said up shielding layer 37 consists of for example, a NiFe alloy (permalloy), Sendust, etc., and is formed of plating or sputtering.

[0061] Gap length Gl is determined at spacing between the lower shielding layer 20 of the part in which said multilayers 33 were formed, and the up shielding layer 37, i.e., the die-length dimension of the illustration Z direction from the inferior surface of tongue of the antiferromagnetism layer 21 to the top face of a protective layer 27, by this operation gestalt.

[0062] The lower shielding layer 20 and the up shielding layer 37 on which the magnetic sensing element shown in drawing 1 functions as an electrode are the structure where the current which said multilayers 33 touch up and down, is formed, and flows from said shielding layers 20 and 37 is called a film surface and the CPP (current perpendicular to the plane) mold which flows perpendicularly (illustration Z direction) in the inside of said multilayers 33.

[0063] Hereafter, the characteristic part of the magnetic sensing element shown in drawing 1 is explained. As shown in drawing 1 , it is the both sides of the truck cross direction (the direction of illustration X) of said multilayers 33, and the side shielding layer 35 is formed between said lower shielding layer 20 and the up shielding layer 37.

[0064] Thus, by this invention, the upper and lower sides of said multilayers 33 and both-sides right and left become the configuration mostly surrounded in the shielding layer by having prepared the shielding layer (side shielding layer 35) also in the both sides of said multilayers 33. Therefore, the leakage field from the adjoining truck of the record medium conventionally made into the problem as narrow track-ization progressed is appropriately absorbed in said side shielding layer 35, and can prevent said leakage field invading in said multilayers 33 as much as possible.

[0065] With the operation gestalt shown in drawing 1 here, the width method in the truck cross direction (the direction of illustration X) of the top face of said multilayers 33 is optical width-of-recording-track O-Tw. Optical width-of-recording-track O-Tw is the width method measured with the optical microscope or the electron microscope.

[0066] On the other hand, effective regenerative-track width of face (or it is also called magnetic regenerative-track width of face) is measured by for example, the full truck profile method or the micro truck profile method.

[0067] The full truck profile method records the signal on the record medium with the recording track of the recording track width of face Ww broader than the component width of face of the magnetic sensing element R, as shown in drawing 15 , it makes a magnetic sensing element scan crosswise [ truck ] (the direction of X) on a recording track, and measures the relation between the location of the recording track cross direction (the direction of X) of a magnetic sensing element, and a playback output. The measurement result is shown in the drawing 15 bottom.

[0068] When the playback wave of this measurement result is seen, near the center of a recording track, it turns out that a playback output becomes low as a playback output becomes high and it separates from the center of a recording track.

[0069] The intersection of the tangent and the X-axis in the point Pa that the playback output on a playback wave becomes 50% of maximum, and Point Pb is made into Point Pc and Point Pd, respectively. The difference (RW) of the distance A between Point Pc and Point Pd and the distance B between Point Pa and Point Pb (half-value width) serves as effective regenerative-track width of face of a magnetic sensing element. Here, it becomes the half-value-width B= effective recording track width of face Ww.

[0070] Effective regenerative-track width of face is a width method which actually functions as the width of recording track. Therefore, it is the most desirable if said effective regenerative-track width of face and optical width-of-recording-track O-Tw have an equal relation.

[0071] By this invention, by having formed the side shielding layer 35 in the both sides of the truck cross direction (the direction of illustration X) of said multilayers 33, the leakage field from the adjoining truck of a record medium can be appropriately absorbed in said side shielding layer 35, and said amount of leakage fields which invades into said multilayers 33 can be made small compared with the former. Therefore, in this invention, said effective regenerative-track width of face is made to the magnitude near the width method of optical width-of-recording-track O-Tw compared with the former, the effective regenerative-track broadening which became remarkable by narrow track-ization can be controlled conventionally, and it becomes possible to decrease faults, such as generating of side leading, effectively.

[0072] In this invention, the following devices are made that the effective regenerative-track broadening further

described above should be controlled effectively.
[0073] In this invention, the distance between both-sides end-face 33a in the truck cross direction (the direction of illustration X) of said multilayers 33 and the side shielding layer 35 is adjusted appropriately. Although the insulating layer 34 intervenes with this operation gestalt between both-sides end-face 33a of said multilayers 33, and the side shielding layer 35, by this invention, effective regenerative-track broadening is more appropriately controlled by adjusting the thickness of this insulating layer 34 appropriately.
[0074] As for the thickness in the truck cross direction (the direction of illustration X) of the insulating layer 34 which intervenes in this invention between both-sides end-face 33a of said multilayers 33, and the side shielding layer 35, it is desirable that it is 0.06 micrometers or less. It is checked by the experiment which it mentions later that the value which lengthened optical width-of-recording-track O-Tw is set to 0.015 micrometers or less from effective regenerative-track width of face by this.
[0075] Moreover, as for the thickness in the truck cross direction (the direction of illustration X) of the insulating layer 34 which intervenes in this invention between both-sides end-face 33a of said multilayers 33, and the side shielding layer 35, it is more desirable that it is 0.03 micrometers or less. It is checked by the experiment which it mentions later that the value which lengthened optical width-of-recording-track O-Tw is set to 0.01 micrometers or less from effective regenerative-track width of face by this.
[0076] In this invention, by adjusting the thickness of the insulating layer 34 which intervenes as mentioned above between both-sides end-face 33a of multilayers 33, and the side shielding layer 35, effective regenerative-track broadening can be stopped appropriately and generating of side leading can be controlled effectively.
[0077] As for the thickness to the direction of illustration X of said insulating layer 34 formed in both-sides end-face 33a of said multilayers 33 in this invention, it is desirable that it is 0.003 micrometers or more. Said insulating layer 34 is formed in order to control that the current which flows to a film surface and a perpendicular direction carries out splitting of the inside of said multilayers 33 to said side shielding layer 35. Therefore, said insulating layer 34 has the need of having a certain amount of thickness, and it is 0.003 micrometers.
[0078] When the non-magnetic material layer 23 which constitutes said multilayers 33 from this invention is the tunnel mold magneto-resistive effect mold component formed by insulating materials, such as aluminum 2O3 and SiO2, existence of an insulating layer 34 becomes important especially between both-sides end-face 33a of said multilayers 33, and the side shielding layer 35. Because, both-sides end-face 33a of said multilayers 33 and the side shielding layer 35 touch directly, and are formed. Or when the current which flows said multilayers 33 to a film surface and a perpendicular direction when the thickness of said insulating layer 34 is very thin flows between the free magnetic layer 24 and the fixed magnetic layer 22, it is because it mainly flows to the side shielding layer 35 side with small resistance more nearly electric than the non-magnetic material layer 23 formed by the insulating material (namely, -- shunting) and a playback output becomes extremely small.
[0079] Although it is desirable when making an insulating layer 34 intervene between both-sides end-face 33a of said multilayers 33 and the side shielding layer 35 also in the case of the spin bulb GMR mold magneto-resistive effect component in which said non-magnetic material layer 23 was formed with nonmagnetic electrical conducting materials, such as Cu, stops splitting of the current to said side shielding layer 35, the need for said insulating layer 34 is low compared with the case of a tunnel mold magneto-resistive effect mold component. However, the existence of an insulating layer 34 cannot be judged [ whether it is only the configuration of a spin bulb GMR mold magneto-resistive effect component, and ] with a chisel, but is an element also with the important quality of the material of the side shielding layer 35. For example, it is because it will become easy to shunt the current which should flow the inside of said multilayers 33 toward said side shielding layer 35 from said free magnetic layer 24 and the fixed magnetic layer 22 if both-sides end-face 33a of multilayers 33 and the side shielding layer 35 touch directly and are formed, when the resistivity of the side shielding layer 35 is lower than the resistivity of the free magnetic layer 24 which constitutes especially the multilayers 33, and the fixed magnetic layer 22. Therefore, it is desirable to be formed with the magnetic material which has resistivity with said side shielding layer 35 higher than said fixed magnetic layer 22 and free magnetic layer 24 in this invention.
[0080] Next, with the operation gestalt shown in drawing 1 , said lower shielding layer 20 is formed in contact with the inferior surface of tongue of multilayers 33, and said lower shielding layer 20 has a role of a lower electrode. For example, said lower electrode can also be prepared separately from the lower shielding layer 20 ( drawing 7 explains the operation gestalt).
[0081] However, if said lower shielding layer 20 is used as a lower electrode, since there is no need of preparing a lower electrode and a lower shielding layer separately, the manufacture process of a magnetic sensing element can be simplified, gap length G1 further determined at intervals of the illustration Z direction between the lower shielding layer 20 and the up shielding layer 37 can be shortened, and the magnetic sensing element which can respond can be manufactured suitable for a raise in recording density.
[0082] And since said lower shielding layer 20 and multilayers 33 touch and are formed, said lower shielding layer 20 can be made to be able to absorb effectively the leakage field generated near the inferior surface of tongue of

said multilayers 33 among the leakage fields from the adjoining truck which invades from illustration Y, and generating of the error at the time of the off-track by side leading can offer the magnetic sensing element which was excellent with few reproducing characteristics.
[0083] With the operation gestalt shown in drawing 1 , said up shielding layer 37 as well as said lower shielding layer 20 is formed in contact with the top face of said multilayers 33. Therefore, said up shielding layer 37 can be made to be able to absorb effectively the leakage field generated near the top face of said multilayers 33 among the leakage fields from the adjoining truck which invades from illustration Y, and the magnetic sensing element in which generating of side leading was excellent with few reproducing characteristics can be offered.
[0084] By moreover, the thing which the lower shielding layer 20 and the up shielding layer 37 are made electrode layer combination, and a magnetic sensing element touches up and down, and is formed as described above It is made to the configuration which surrounds the upper and lower sides of said multilayers 33, and both-sides right and left in the shielding layers 20, 35, and 37, without keeping away from said multilayers 33 more. generating of side leading which does not gather the excessive leakage field from a record medium -- the former -- extremely -- stopping -- a line -- it becomes possible to offer the magnetic sensing element which can raise resolution.
[0085] For example, in the case of the magnetic sensing element of the CIP mold which passes a current in the direction parallel to the film surface of said multilayers 33, a configuration like drawing 1 is unrealizable. because, cannot perform primarily making the lower shielding layer 20 and the up shielding layer 37 serve a double purpose as an electrode layer, and in being a CIP mold For example, the configuration which prepares a hard bias layer in the both sides of the truck cross direction of the free magnetic layer 24 at least is common (for example, although there is a thing called the exchange bias method which prepared the antiferromagnetism layer on said free magnetic layer 24). Since multilayers 33 are not formed in abbreviation trapezoidal shape like drawing 1 , but the width method of the truck cross direction of said multilayers 33 is extended for a long time than optical width-of-recording-track O-Tw and is formed by this method It is because the whole both sides of said multilayers 33 are not made to the configuration fill uped with the side shielding layer 35 therefore there is no tooth space in which the side shielding layer 35 is formed like this invention.
[0086] With the operation gestalt shown in drawing 1 , as already explained, the bias layer 26 is formed through the non-magnetic layer 25 on the free magnetic layer 24. And magnetization of said free magnetic layer 24 is single-domain-ized in the direction of illustration X because the vertical bias field from this bias layer 26 flows into said free magnetic layer 24.
[0087] Although this bias method is called an in stack bias (instack bias) method, this bias method has practical use value only at the magnetic sensing element of a CPP mold. In the case of a CPP mold, since a current flows to the film surface and perpendicular direction of multilayers 33, even if it forms said bias layer 26 on the free magnetic layer 24, it does not become the path to which existence of said bias layer 26 carries out splitting of the current. However, in a CIP mold, in order to flow in the direction where a current is parallel to the film surface of multilayers 33, if an in stack bias method like this invention is used for a CIP mold, the current which flows in said bias layer 26 will become a splitting loss, therefore the fall of a playback output will be caused temporarily. Therefore, this in stack bias method is a bias means effective in the magnetic sensing element of a CPP mold, it is using said in stack bias method especially, and it becomes possible to manufacture the magnetic sensing element which can respond to narrow track-ization appropriately.
[0088] However, since it is strongly magnetized to the truck cross direction and sensibility stops being able to improve [ said free magnetic layer 24 ] flux reversal to the external magnetic field from a record medium when the vertical bias field which flows into said free magnetic layer 24 from said bias layer 26 is too strong, there is the need of adjusting said vertical bias magnetic field strength appropriately. Said vertical bias magnetic field strength receives effect in the thickness of the non-magnetic layer 25 which intervenes between said bias layers 26 and free magnetic layers 24, and as the thickness of said non-magnetic layer 25 is thin, said vertical bias field becomes stronger. Therefore, the magnitude of the vertical bias field which adjusts the thickness of said non-magnetic layer 25 appropriately, and flows into the free magnetic layer 24 from said bias layer 26 must be adjusted. It is desirable to form the thickness of said non-magnetic layer 25 by 0.002-0.01 micrometers by this invention.
[0089] Next, as shown in drawing 1 , it is desirable that said insulating layer 34 is formed in top-face 20a of said lower shielding layer 20, namely, an insulating layer 34 intervenes between said side shielding layer 35 and the lower shielding layer 20. It becomes possible to lose that the flowing current carries out splitting of between said lower shielding layer 20 and the up shielding layer 37 to the side shielding layer 35 from said lower shielding layer 20, and to manufacture a magnetic sensing element with a large playback output by this. As for the thickness of the insulating layer 34 formed between said lower shielding layer 20 and the side shielding layer 35, it is desirable that it is 0.003 micrometers - 0.01 micrometers.
[0090] With the operation gestalt similarly shown in drawing 1 , an insulating layer 36 intervenes also between said side shielding layer 35 and the up shielding layer 37. Said insulating layer 36 is formed from insulating materials, such as aluminum 2O3 and SiO2. It becomes possible to lose that the flowing current carries out splitting of

between said up shielding layer 37 and the lower shielding layer 20 to the side shielding layer 35 from said up shielding layer 37, and to manufacture a magnetic sensing element with a large playback output by this. As for the thickness of the insulating layer 36 formed between said up shielding layer 37 and the side shielding layer 35, it is desirable that it is 0.003 micrometers - 0.01 micrometers.
[0091] Next, the quality of the material of said side shielding layer 35 is explained below. Although the same quality of the material as the lower shielding layer 20 or the up shielding layer 37 is sufficient as said side shielding layer 35, it may be formed with the different quality of the material.
[0092] As shown in drawing 1 , separation formation of said side shielding layer 35 is carried out from said lower shielding layer 20 or the up shielding layer 37. Therefore, it becomes possible to form said side shielding layer 35 with the different quality of the material from the up shielding layer 37 and the lower shielding layer 20.
[0093] By forming said side shielding layer 35 with the different quality of the material from the up shielding layer 37 or the lower shielding layer 20, it becomes possible to form said side shielding layer 35 as follows.
[0094] That is, although it is common that plating formation is carried out with the quality of the materials, such as a permalloy (NiFe alloy), as for the lower shielding layer 20 and the up shielding layer 37 with very thick thickness, since said side shielding layer 35 is very thin thickness compared with said lower shielding layer 20 or the up shielding layer 37, it becomes possible to form said side shielding layer 35 with a spatter or the quality of the material which can be vapor-deposited. In addition, at drawing 1 , although the direction of said side shielding layer 35 is illustrated by thick thickness compared with the lower shielding layer 20 or the up shielding layer 37, with a real product, the direction of said lower shielding layer 20 or the up shielding layer 37 is formed by thickness thicker than said side shielding layer 35. Although said lower shielding layer 20 and the up shielding layer 37 are 1 micrometer - about 3 micrometers thickness, specifically, the thickness of said side shielding layer 35 is 0.01 micrometers - about 0.1 micrometers thickness. In addition, as gap length G1 becomes short, it cannot be overemphasized that the thickness of said side shielding layer 35 becomes small.
[0095] Since a spatter can also form said side shielding layer 35 in this invention as described above, the selectivity of the quality of the material of said side shielding layer 35 can be extended.
[0096] As for said side shielding layer 35, the presentation ratio of nickel is formed by the soft magnetic materials of an about 80 at(s)% NiFe alloy or others. Like the lower shielding layer 20 or the up shielding layer 37, since properties, such as high permeability and a low magnetostriction constant, are required, there is the need of choosing the soft magnetic materials which have such a property in said side shielding layer 35.
[0097] The magnetic material with which for example, Co system amorphous material and an empirical formula consist of Fe-M-O (however, one sort or two sorts or more of elements with which Element M is chosen from Ti, Zr, Hf, Nb, Ta, Cr, Mo, Si, P, C, W, B, aluminum, Ga, germanium, and rare earth elements) can be chosen as other soft magnetic materials. Each can form the side shielding layer 35 formed with these quality of the materials with a spatter or vacuum deposition.
[0098] As a Co system amorphous material, there is Co-X (however, one sort or two sorts or more as which Element X is chosen from Ti, Mo, W, Si, P, Zr, Nb, Hf, Ta, and B), for example. The Fe-M-O ingredient serves as a phase organization with which the amorphous phase and the microcrystal phase of bcc-Fe mingled.
[0099] These Co(es) system amorphous material and a Fe-M-O ingredient have high resistivity compared with a NiFe alloy etc. Although an insulating layer 34 intervenes with the operation gestalt shown in drawing 1 between both-sides end-face 33a of multilayers 33, and the side shielding layer 35, it is more desirable to enable it to control further the current which forms said side shielding layer 35 with high specific resistance ingredients, such as Co system amorphous material, and carries out splitting to said side shielding layer 35 from multilayers 33.
[0100] It is desirable that it is higher than the specific resistance of the free magnetic layer 24 from which the specific resistance of said side shielding layer 35 constitutes multilayers 33 about resistivity, or the fixed magnetic layer 22. If said side shielding layer 35 is formed with the quality of the material which has resistivity higher than the resistivity of said free magnetic layer 24 and fixed magnetic layer 22, the current loss which carries out splitting to said side shielding layer 35 can be reduced more appropriately, and it will become possible to manufacture a magnetic sensing element with a high playback output. in addition, resistivity with the side shielding layer 35 higher than the free magnetic layer 24 and the fixed magnetic layer 22 which were formed with magnetic materials, such as a NiFe alloy, formed with the above-mentioned Co system amorphous material or the Fe-M-O ingredient -- having -- concrete -- being alike -- it is 100-100,000micro ohm-cm extent.
[0101] Next, the formation location of top-face 35a of said side shielding layer 35 is explained below. As shown in drawing 1 , top-face 35a of said side shielding layer 35 is being formed in the same height as top-face 33b of said multilayers 33, or formed in a location higher than top-face 33b of said multilayers 33 preferably. By this, through said insulating layer 34, said side shielding layer 35 can counter in the truck cross direction certainly, and therefore the both sides of the truck cross direction (the direction of illustration X) of said multilayers 33 can control effective regenerative-track broadening effectively, and can control generating of side leading appropriately. However, even if top-face 35a of said side shielding layer 35 is a location lower than top-face 33b of said

multilayers 33, it becomes possible to control effective regenerative-track broadening effectively and to control generating of side leading compared with the case where the side shielding layer 35 is not formed like before. In addition, when top-face 35a of said side shielding layer 35 is formed in a location lower than top-face 33b of said multilayers 33, about the formation location of said side shielding layer 35, it is desirable to form said side shielding layer 35 so that said side shielding layer 35 may counter certainly the both sides of the truck cross direction of the free magnetic layer 24 at least.

[0102] Moreover, uniaxial anisotropy from which the truck cross direction (the direction of illustration X) serves as an easy axis like the lower shielding layer 20 and the up shielding layer 37 as for said side shielding layer 35 needs to be given. For this reason, spatter membrane formation is carried out all over a magnetic field, or annealing in a magnetic field of said side shielding layer 35 is carried out, and uniaxial anisotropy is given. The shielding function of said side shielding layer 35 can be raised by this, and while becoming possible to control effectively the effective regenerative-track broadening of a magnetic sensing element, the instability of a playback wave resulting from the instability of the magnetic-domain structure of shielding is avoidable.

[0103] After drawing 2 , it is another operation gestalt of the magnetic sensing element in this invention. Drawing 2 is the sectional view which saw the magnetic sensing element of the gestalt of operation of the 2nd of this invention from the opposed face side with a record medium. In addition, drawing 2 fractures and shows only the central part of the component prolonged in the direction of X.

[0104] A different point from drawing 1 in the operation gestalt of drawing 2 is that apply to both-sides end-face 33a of said multilayers 33 from top-face 20a of the lower shielding layer 20 by which extension formation was carried out, and the insulating layer 34 is not formed in the both sides of the truck cross direction (the direction of illustration X) of multilayers 33 like drawing 1 in drawing 2 .

[0105] The operation gestalt shown in drawing 2 is effective in the spin bulb GMR mold MAG sensing element especially constituted by the non-magnetic material layer 23 using nonmagnetic electrical conducting materials, such as Cu. That is, with said spin bulb mold magneto-resistive effect component, when the current which flows from the lower shielding layer 20 and the up shielding layer 37 to said multilayers 33 flows said multilayers 33 to a film surface and a perpendicular direction, it can maintain the big playback output that it is hard to shunt said current toward the direction of said side shielding layer 35.

[0106] Although said side shielding layer 35 is formed in drawing 2 directly in contact with both-sides end-face 33a of said multilayers 33 The ** which does not mind the non-magnetic material layer 23 formed by Cu with electric resistance low in case a current flows between the free magnetic layer 24 and the fixed magnetic layer 22 etc., It cannot happen easily to flow in the high side shielding layer 35 of electric resistance compared with the tunnel mold magneto-resistive effect mold component in which the non-magnetic material layer 23 was formed by the insulating material. For this reason, in the case of a spin bulb GMR mold MAG sensing element, especially by this invention, it is thought that it is not necessary to form an insulating layer 34 in both-sides end-face 33a of said multilayers 33. It is possible to be able to stop effective regenerative-track broadening more effectively and to control generating of side leading compared with the former by this.

[0107] It is more desirable that said side shielding layer 35 is formed with the magnetic material which has resistivity higher than the fixed magnetic layer 22 and the free magnetic layer 24 with the operation gestalt shown in drawing 2 . The current which flows to a film surface and a perpendicular direction stops easily being able to shunt the inside of said multilayers 33 toward said side shielding layer 35 more appropriately due to this.

[0108] Then, as for said side shielding layer 35, in the case of the operation gestalt shown in drawing 2 by this invention, it is more desirable to be formed with the magnetic material with which Co system amorphous material and an empirical formula consist of Fe-M-O (however, one sort or two sorts or more of elements with which Element M is chosen from Ti, Zr, Hf, Nb, Ta, Cr, Mo, Si, P, C, W, B, aluminum, Ga, germanium, and rare earth elements).

[0109] It becomes possible for these magnetic materials to have high resistivity compared with the NiFe alloy and CoFe alloy which are used as the free magnetic layer 24 or a fixed magnetic layer 22, to be able to lose the splitting loss to said side shielding layer more effectively by using the side shielding layer 35 formed with said Co system amorphous material and Fe-M-O ingredient, and to form a magnetic sensing element with a large playback output.

[0110] With the operation gestalt shown in drawing 2 , the insulating layer 36 is formed in top-face 35a of said side shielding layer 35. In case said insulating layer 36 will intervene between said up shielding layer 37 and the side shielding layer 35 and a current flows from said up shielding layer 37 to said multilayers 33 by this, it can prevent appropriately said current carrying out splitting to said side shielding layer 35 from said up shielding layer 37, and further improvement in a playback output can be aimed at.

[0111] Moreover, as shown in drawing 3 (sectional view where drawing 3 saw the magnetic sensing element of the gestalt of operation of the 2nd of this invention from the opposed face side with a record medium) The direction where the insulating layer 34 is formed also in top-face 20a of the lower shielding layer 20 which extended crosswise [ truck ] (the direction of illustration X) from both-sides end-face 33a of said multilayers 33 In case said

current flows from said lower shielding layer 20 to said multilayers 33, said current can protect appropriately carrying out splitting to said side shielding layer 35 from said lower shielding layer 20, can aim at further improvement in a playback output, and is desirable.

[0112] In addition, the operation gestalt which is established only between said lower shielding layer 20 and the side shielding layer 35, and is not established between said up shielding layer 37 and the side shielding layer 35 is sufficient as said insulating layer 34.

[0113] The operation gestalt from which said insulating layer furthermore is not prepared for the both sides between said lower shielding layer 20 and the side shielding layer 35 and between the up shielding layer 37 and the side shielding layer 35 by this invention is sufficient.

[0114] Drawing 4 is the sectional view which saw the magnetic sensing element of the gestalt of operation of the 4th of this invention from the opposed face side with a record medium.

[0115] Although said side shielding layer 35 was the monolayer structure of a magnetic material with the operation gestalt shown in drawing 1 thru/or drawing 3 , the side shielding layer 45 has a laminated structure of the 1st shielding layer 43 and the 2nd shielding layer 44 with the operation gestalt shown in drawing 4 .

[0116] For example, the 1st shielding layer 43 equivalent to a lower layer is formed with a NiFe alloy etc., and the 2nd shielding layer 44 which hits the upper layer is formed with the magnetic material which consists of a Co system amorphous material, a Fe-M-O ingredient (however, one sort or two sorts or more of elements with which Element M is chosen from Ti, Zr, Hf, Nb, Ta, Cr, Mo, Si, P, C, W, B, aluminum, Ga, germanium, and rare earth elements), etc.

[0117] It becomes possible to be able to stop appropriately that a current carries out splitting to said side shielding layer 45 side, and to manufacture a magnetic sensing element with a high playback output by this by forming said 2nd shielding layer 44 with the magnetic material which has resistivity higher than the 1st shielding layer 43. Like especially drawing 2 and drawing 3 , when it is the configuration that an insulating layer is not prepared between both-sides end-face 33a of multilayers 33, and the side shielding layer 45, it is effective.

[0118] Although it has not exceeded in it if it can form with the magnetic material which has the properties (namely, high permeability, a low magnetostriction constant, etc.) which were excellent in the shielding function with high specific resistance in said 2nd shielding layer 44 In being inferior to the lower shielding layer 20 or the up shielding layer 37 a little [, such as permeability, ] just because it gives priority to resistivity By using the magnetic material which has the property excellent in the shielding function for the 1st shielding layer 43 While being able to prevent appropriately the leakage field from the adjoining truck of a record medium invading into multilayers 33, stopping effective regenerative-track broadening therefore and being able to control generating of side leading, it becomes possible for there to be no splitting loss and to manufacture a magnetic sensing element also with a high playback output.

[0119] In addition, although said side shielding layer 45 is the two-layer structure of the 1st shielding layer 43 and the 2nd shielding layer 44 with the operation gestalt shown in drawing 4 , it cannot be overemphasized that this may be the laminated structure of three or more layers.

[0120] Drawing 5 is the sectional view which saw the magnetic sensing element of the gestalt of operation of the 5th of this invention from the opposed face side with a record medium.

[0121] Unlike the operation gestalt of drawing 1 thru/or the magnetic sensing element of 4, the operation gestalt of the magnetic sensing element of drawing 5 has composition formed by the switched connection film by which the side shielding layer 42 consists of an antiferromagnetism layer 40 and a soft magnetism layer 41.

[0122] The switched connection film which consists of an antiferromagnetism layer 40 and a soft magnetism layer 41 by drawing 5 can be used at this invention because said side shielding layer 42 of said lower shielding layer 20 or the up shielding layer 37 is the configuration of having dissociated.

[0123] It is Element X (however, X) like the antiferromagnetism layer 21 from which said antiferromagnetism layer 40 constitutes multilayers 33. It may be formed with the antiferromagnetism ingredient containing Mn. the inside of Pt, Pd, Ir, Rh, Ru, and Os -- one sort or two sorts or more of elements -- it is -- Or Element X and element X' (however, element X') Ne, Ar, Kr, Xe, Be, B, C, N, Mg, aluminum, Si, P, Ti, V, Cr, Fe, Co, nickel, Cu, Zn, Ga, germanium, Zr, Nb, Mo, Ag, Cd, Sn, Hf, Ta, W, Re, Au, Pb, and the inside of rare earth elements -- one sort or two sorts or more of elements -- it is -- it may be formed with the antiferromagnetism ingredient containing Mn or IrMn.

[0124] Or said antiferromagnetism layer 40 may be formed by NiMn, alpha-Fe 2O3, FeMn which can generate a switched connection field between said soft magnetism layers 41 even if it does not add heat treatment further, etc.

[0125] Said antiferromagnetism layer 40 is formed in order to give uniaxial anisotropy to the said soft magnetism layer 41 instead of a thing for magnetizing strongly the soft magnetism layer 41 formed on said antiferromagnetism layer 40 unlike the antiferromagnetism layer 21 which constitutes multilayers 33. If said soft magnetism layer 41 is magnetized strongly, for example, magnetization is fixed like the fixed magnetic layer 22, it will become impossible to operate said soft magnetism layer 41 as a side shielding layer 42.

[0126] The switched connection field generally generated between said antiferromagnetism layers 40 and soft magnetism layers 41 The thickness of said antiferromagnetism layer 40 becomes thick, and on the other hand, if the thickness of the soft magnetism layer 41 becomes thin, since becoming large is known, the thickness of said antiferromagnetism layer 40 and the soft magnetism layer 41 is adjusted appropriately. Uniaxial anisotropy or an one direction anisotropy must be made to give by giving the switched connection field which is not so strong in the soft magnetism layer 41. For example, the thickness of about 50-100A and the soft magnetism layer 41 of the thickness of said antiferromagnetism layer 40 is about 200-1000A.
[0127] Next, the NiFe alloy with which said soft magnetism layer 41 is generally used as a ferromagnetic ingredient from the former, Although it may be formed with a CoFe alloy, a CoFeNi alloy, etc., Co system amorphous material and an empirical formula are Fe-M-O (however, Element M). You may be the magnetic material which consists of one sort or two sorts or more of elements chosen from Ti, Zr, Hf, Nb, Ta, Cr, Mo, Si, P, C, W, B, aluminum, Ga, germanium, and rare earth elements.
[0128] Moreover, said soft magnetism layer 41 may be not monolayer structure but a laminated structure more than two-layer, as shown in drawing 4 .
[0129] If a switched connection field occurs between the antiferromagnetism layer 40 and the soft magnetism layer 41 by membrane formation among a magnetic field, or heat treatment among a magnetic field, uniaxial anisotropy or an one direction anisotropy will be given in the direction of illustration X, and said soft magnetism layer 41 will function as a side shielding layer.
[0130] Moreover, the insulating layer 34 which intervenes between both-sides end-face 33a of said multilayers 33 and the side shielding layer 42 does not need to be formed.
[0131] Drawing 6 is the sectional view which saw the magnetic sensing element of the gestalt of operation of the 6th of this invention from the opposed face side with a record medium.
[0132] With the operation gestalt shown in drawing 6 , rather than said multilayers 33, it applies to both-sides end-face 33a of said multilayers 33 from top-face 20a of the lower shielding layer 20 which extended crosswise [ truck ] (the direction of illustration X), an insulating layer 34 is formed, and the side shielding layer 35 is formed on said insulating layer 34. Furthermore, with this operation gestalt, the bias substrate layer 50 is formed on said side shielding layer 35, and the hard bias layer 51 is formed on said bias substrate layer 50.
[0133] With the operation gestalt shown in drawing 6 , it is not the configuration that the bias layer 26 was formed through the non-magnetic layer 25 on the free magnetic layer 24, like the operation gestalt shown in drawing 1 thru/or drawing 5 . With the operation gestalt shown in drawing 6 , multilayers 33 have from the bottom the composition that the laminating was carried out to the order of the antiferromagnetism layer 21, the fixed magnetic layer 22, the non-magnetic material layer 23, the free magnetic layer 24, and a protective layer 27.
[0134] And as shown in drawing 6 , the hard bias layer 51 is formed in the both sides of the truck cross direction (the direction of illustration X) of said free magnetic layer 24, and magnetization of said free magnetic layer 24 is single-domain-ized in the direction of illustration X by the vertical bias field from said hard bias layer 51.
[0135] With the operation gestalt shown in drawing 6 , top-face 35a of said side shielding layer 35 is formed in the bottom compared with the inferior surface of tongue of said free magnetic layer 24. Although it is more desirable to form said side shielding layer 35 in the both sides of said multilayers 33 by thick thickness as much as possible, if top-face 35a of the side shielding layer 35 is located more nearly up than the inferior surface of tongue of said free magnetic layer 24 The thickness of the hard bias layer 51 which counters the both sides of the truck cross direction of said free magnetic layer 24 becomes thin. Since the vertical bias field of moderate magnitude does not flow into said free magnetic layer 24 from said hard bias layer 51 but it stops being able to carry out [ single domain ]-izing of the magnetization of said free magnetic layer 24 appropriately, it is not desirable.
[0136] The quality of the material explained by drawing 1 , i.e., a NiFe alloy, Co system amorphous material, a Fe-M-O ingredient, etc. can be used for said side shielding layer 35.
[0137] The bias substrate layer 50 formed on said side shielding layer 35 is formed in order to weaken the magnetic interference between said hard bias layer 51 and the side shielding layer 35 (or it insulates). Although this bias substrate layer 50 may be formed by insulating materials, such as aluminum 2O3 and SiO2, you may be non-magnetic materials, such as Ta. Or it turns out that the remanence ratio and coercive force of said hard bias layer 51 can be raised by forming said bias substrate layer 50 by Cr.
[0138] The hard bias layer 51 formed on said bias substrate layer 50 is formed by the existing permanent magnet film, such as CoPtCr and CoPt.
[0139] With the operation gestalt shown in drawing 6 , the insulating layer 36 formed by insulating materials, such as aluminum 2O3 and SiO2, on said hard bias layer 51 is formed. It becomes possible to be able to protect from said up shielding layer 37 that the current which flows to said multilayers 33 carries out splitting to said hard bias layer 51, and to manufacture a magnetic sensing element with a big playback output by forming said insulating layer 36 on said hard bias layer 51.
[0140] Moreover, although the insulating layer 34 is formed with the operation gestalt shown in drawing 6 between

both-sides end-face 33a of said multilayers 33, the side shielding layer 35, and the hard bias layer 51 This was for preventing carrying out splitting to said side shielding layer 35 grade, without a current minding the non-magnetic material layer 23, when the non-magnetic material layer 23 which constitutes especially the multilayers 33 was the tunnel mold magneto-resistive effect mold component formed by insulating materials, such as aluminum 2O3, as drawing 1 explained. With the operation gestalt which is shown in drawing 6 in addition to it, since the insulating layer 34 intervenes between both-sides end-face 33a of said multilayers 33, and the hard bias layer 51, it can weaken because the strong vertical bias field from said hard bias layer 51 minds said insulating layer 34, and magnetization of said free magnetic layer 24 can control that the vertical bias field from said hard bias layer 51 is magnetized strongly, and sensibility falls. When especially narrow track-ization was promoted and a strong vertical bias field flows into said free magnetic layer 24 from said hard bias layer 51, it is desirable to become a serious problem, since said free magnetic layer 24 whole is magnetized strongly and playback sensibility falls greatly, therefore to make an insulating layer 34 intervene between both-sides end-face 33a of said multilayers 33 and the hard bias layer 51 for promotion of future narrow-track-izing.
[0141] Drawing 7 is the sectional view which saw the magnetic sensing element of the gestalt of operation of the 7th of this invention from the opposed face side with a record medium.
[0142] The lower electrode layer 54 is formed in the multilayers 33 bottom with the operation gestalt shown in drawing 7 . Said lower electrode layer 54 is further extended and formed in the both sides of the truck cross direction (the direction of illustration X) rather than both-sides end-face 33a of said multilayers 33, and the side shielding layer 35 is formed in top-face 54a of the lower electrode layer 54 which extended through the insulating layer 34. Said lower electrode layer 54 is formed by alpha-Ta, Au, Cr and Cu (copper), W (tungsten), etc.
[0143] As shown in drawing 7 , the lower shielding layer 52 made from a magnetic material is formed in the bottom of said lower electrode layer 54 through the lower gap layer 53 formed with aluminum 2O3 etc.
[0144] Moreover, as shown in drawing 7 , the up shielding layer 57 is formed through the up gap layer 56 which the up electrode layer 55 was formed on said multilayers 33 and the side shielding layer 35, and was formed with aluminum 2O3 etc. on said up electrode layer 55. Moreover, as shown in drawing 7 , between said up electrode layer 55 and the side shielding layer 35, the insulating layer 36 formed with aluminum 2O3 etc. is formed. Moreover, said up electrode layer 55 is formed by alpha-Ta, Au, Cr and Cu (copper), W (tungsten), etc. like the lower electrode layer 54.
[0145] With the operation gestalt shown in drawing 7 , the lower electrode layer 54 and the up electrode layer 55 are formed independently [ said lower shielding layer 52 and the up shielding layer 57 ]. Although manufacture makes complicated the lower shielding layer 20 and the up shielding layer 37 like the operation gestalt shown in drawing 1 thru/or drawing 6 compared with the case where it is made to function also as an electrode layer Also in the operation gestalt shown in drawing 7 , it becomes possible to stop effective regenerative-track broadening compared with the former, and to control generating of side leading appropriately by the side shielding layer 35 being formed in the both sides of the truck cross direction (the direction of illustration X) of said multilayers 33.
[0146] Drawing 8 is the sectional view which saw the magnetic sensing element of the gestalt of operation of the 8th of this invention from the opposed face side with a record medium.
[0147] With this operation gestalt, the film configuration of multilayers 33 is the same as the thing of drawing 1 . With this operation gestalt, said multilayers 33 are formed on the lower shielding layer 20. Furthermore, it applies on said lower shielding layer 20 from the both-sides end face of the truck cross direction of said multilayers 33, and the insulating layer 34 is formed.
[0148] And it applies to the top face of said multilayers 33 from on said insulating layer 34, and the shielding layer 70 is formed. The side shielding layer 35 and the up shielding layer 37 which show said shielding layer 70 to drawing 1 are formed by one.
[0149] Thus, when forming the side shielding layer 35 and the up shielding layer 37 by one, a production process can be easy-ized compared with the case where it is separate and said side shielding layer 35 and the up shielding layer 37 are formed like drawing 1 .
[0150] Moreover, said shielding layer 70 is formed with the magnetic material with which others and Co system amorphous material and an empirical formula consist of Fe-M-O (however, one sort or two sorts or more of elements with which Element M is chosen from Ti, Zr, Hf, Nb, Ta, Cr, Mo, Si, P, C, W, B, aluminum, Ga, germanium, and rare earth elements). [ quality of the materials /, such as a NiFe alloy, / which are generally used as a shielding layer ] As said Co system amorphous material, it is Co-X (however, one sort or two sorts or more as which Element X is chosen from Zr, Nb, Hf, Ta, Ti, Mo, W, P, Si, and B), for example. The Fe-M-O ingredient serves as a phase organization with which the amorphous phase and the microcrystal phase of bcc-Fe mingled.
[0151] In addition, said shielding layer 70 may be monolayer structure, and may be multilayer structure. Moreover, in the case of multilayer structure, the field in which the above-mentioned Co system amorphous material and the empirical formula were formed with the magnetic material of Fe-M-O should just be included in the part.
[0152] In addition, in drawing 8 , the top face of multilayers 33 is touched easily and the part of the shielding layer

70 which functions as an up shielding layer 37 shown in drawing 1 can be formed in it. That is, in this invention, the part which functions as an up shielding layer 70 of said shielding layer 70 can be easily formed as a combination layer with an up electrode.
[0153] Moreover, drawing 9 is the sectional view which saw the magnetic sensing element of the gestalt of operation of the 9th of this invention from the opposed face side with a record medium.
[0154] With this operation gestalt, the film configuration of multilayers 33 is the same as the thing of drawing 1 . With this operation gestalt, the shielding layer 71 is formed and said multilayers 33 are formed on this shielding layer 71. The shielding layer 71 which should turn into the side shielding layer 35 is formed in the both sides of said multilayers 33. With this operation gestalt, the lower shielding layer 20 and the side shielding layer 35 which are shown in drawing 1 are formed by one.
[0155] Said shielding layer 71 is formed to height almost comparable as the top face of said multilayers 33, an insulating layer 36 is formed in shielding 71 top face of the truck cross direction both sides of said multilayers 33, it applies on said multilayers 33 from on said insulating layer 36, and the up shielding layer 37 is formed.
[0156] Said shielding layer 71 is formed with the magnetic material with which others and Co system amorphous material and an empirical formula consist of Fe-M-O (however, one sort or two sorts or more of elements with which Element M is chosen from Ti, Zr, Hf, Nb, Ta, Cr, Mo, Si, P, C, W, B, aluminum, Ga, germanium, and rare earth elements). [ quality of the materials /, such as a NiFe alloy, / which are generally used as a shielding layer ] As said Co system amorphous material, it is Co-X (however, one sort or two sorts or more as which Element X is chosen from Zr, Nb, Hf, Ta, Ti, Mo, W, P, Si, and B), for example. The Fe-M-O ingredient serves as a phase organization with which the amorphous phase and the microcrystal phase of bcc-Fe mingled.
[0157] In addition, said shielding layer 71 may be monolayer structure, and may be multilayer structure. Moreover, in the case of multilayer structure, the field in which the above-mentioned Co system amorphous material and the empirical formula were formed with the magnetic material of Fe-M-O should just be included in the part.
[0158] In addition, in drawing 9 , the inferior surface of tongue of multilayers 33 is touched easily, and the part of the shielding layer 71 which functions as a lower shielding layer 20 shown in drawing 1 can be formed in it. That is, in this invention, the part which functions as a lower shielding layer 20 of said shielding layer 70 can be easily formed as a combination layer with a lower electrode.
[0159] Moreover, by the structure which formed in the up shielding layer 37 or the lower shielding layer 20, and one, magnetization control of said free magnetic layer 24 needs to perform the side shielding layer 35 like drawing 8 or drawing 9 in the bias layer (in this case, it is called a hard bias layer) 26 of the product made from a permanent magnet for example, formed through the non-magnetic layer 25 on said free magnetic layer 24.
[0160] Since drawing 1 , by the way, explained the function of said bias layer 26, detailed explanation is omitted.
[0161] In drawing 8 or drawing 9 , the bias layer 26 must be formed in the direction of thickness of the free magnetic layer 24 because a hard bias layer cannot be put on the both sides of the truck cross direction of said free magnetic layer 24.
[0162] As mentioned above, although the structure of the magnetic sensing element in this invention has been explained using drawing 1 thru/or drawing 9 , this invention is not limited to the structure of the magnetic sensing element shown in drawing 1 thru/or drawing 9 , and can be applied to the magnetic sensing element of the CPP mold of various gestalten. For example, this may be a reverse laminating although laminating formation of the multilayers 33 is carried out from the bottom at the order of the antiferromagnetism layer 21, the fixed magnetic layer 22, the non-magnetic material layer 23, and the free magnetic layer 24 in the magnetic sensing element shown in drawing 1 thru/or drawing 9 . Moreover, said multilayers 33 may be the CPP mold MAG sensing elements of a dual mold. Moreover, even if this consists of only magnetic material layers, also about each layer structure which constitutes said multilayers 33, although the fixed magnetic layer 22 is laminating ferry structure, for example, it may not matter, either, and the free magnetic layer 24 may be laminating ferry structure.
[0163] Moreover, although the laminating is carried out to the order of the antiferromagnetism layer 40 and the soft magnetism layer 41 from the bottom in drawing 4 when using the switched connection film which becomes the side shielding layer 42 from the antiferromagnetism layer 40 and the soft magnetism layer 41 like drawing 5 , laminating formation may be carried out from a reverse laminating, i.e., the bottom, at the order of the soft magnetism layer 41 and the antiferromagnetism layer 40.
[0164] Moreover, with the operation gestalt shown in drawing 1 thru/or drawing 6 and drawing 8 , and drawing 9 , although the lower shielding layer 20 and the up shielding layer 37 also have both electrodes, the film configuration of a shielding layer, a gap layer, and an electrode layer or the shielding layer, and the electrode layer may be electrically connected like drawing 7 in one side.
[0165] In addition, the magnetic sensing element in this invention is not usable only to the thin film magnetic head carried in a hard disk drive unit, and is usable to the magnetic head for tapes, a magnetometric sensor, etc.
[0166] Next, the manufacture approach of the magnetic sensing element in this invention is explained below. Drawing 10 thru/or drawing 12 are 1 process drawings showing the manufacture process of the magnetic sensing

element in this invention, and each drawing is a fragmentary sectional view which cut the magnetic sensing element under manufacture from the direction parallel to an opposed face with a record medium.

[0167] At the process shown in drawing 10 , laminating formation of the antiferromagnetism layer 21, the fixed magnetic layer 22, the non-magnetic material layer 23, the free magnetic layer 24, a non-magnetic layer 25, the bias layer 26, and the protective layer 27 is carried out from the bottom at this order on the lower shielding layer 20 which has a lower electrode first. A spatter and vacuum deposition are used for membrane formation. DC magnetron sputtering, RF spatter, the ion beam spatter method, the long slow spatter method, the collimation spatter method, etc. can be used for a spatter.

[0168] It is desirable to form said antiferromagnetism layer 21 with the Pt-Mn (platinum-manganese) alloy film in this invention. Or it replaces with said Pt-Mn alloy, and it is X-Mn (however, X is any one sort or two sorts or more of elements of Pd, Ir, Rh, and Ru), or you may form by Pt-Mn-X' (however, X' is any one sort or two sorts or more of elements of Pd, Ir, Rh, Ru, Au, and Ag).

[0169] Moreover, in the alloy shown by said PtMn alloy and the formula of said X-Mn, it is desirable that the range of Pt or X is 37 - 63at%. Moreover, in the alloy shown by said PtMn alloy and the formula of said X-Mn, it is more desirable that the range of Pt or X is 47 - 57at%. Unless it specifies especially, the upper limit and minimum of the numerical range shown by - mean the above hereafter.

[0170] Moreover, in the alloy shown by the formula of Pt-Mn-X', it is desirable that the range of X'+Pt is 37 - 63at%. Moreover, in the alloy shown by the formula of said Pt-Mn-X', it is more desirable that the range of X'+Pt is 47 - 57at%. Furthermore, in the alloy shown by the formula of said Pt-Mn-X', it is desirable that the range of X' is 0.2 - 10at%. However, when X' is any one sort or two sorts or more of elements of Pd, Ir, Rh, Ru, Os, nickel, and Fe, as for X', it is desirable that it is the range of 0.2 - 40at%.

[0171] Moreover, it is desirable to form the thickness of said antiferromagnetism layer 21 by 300A or less by 80A or more with this invention.

[0172] Said fixed magnetic layer 22 is the laminating ferry structure of the magnetic layer 28 and magnetic layer 30 which were formed with the CoFe alloy etc., and the nonmagnetic interlayers 29, such as Ru which intervenes between both the magnetic layers 28 and 30. Said free magnetic layer 24 is the laminated structure of the diffusion prevention layers 31, such as a CoFe alloy, and the magnetic material layers 32, such as a NiFe alloy.

[0173] Moreover, said non-magnetic material layer 23 may be formed with nonmagnetic electrical conducting materials, such as Cu, and may be formed by insulating materials, such as aluminum 2O3 and SiO2. When the magnetic sensing element in this invention becomes the configuration of the spin bulb GMR mold magneto-resistive effect component (CPP-GMR) of a CPP mold when said non-magnetic material layer 23 is formed with a nonmagnetic electrical conducting material, and said non-magnetic material layer 23 is formed by the insulating material, the magnetic sensing element in this invention serves as a configuration of a spin bulb tunnel mold magneto-resistive effect mold component (CPP-TMR).

[0174] Moreover, although a non-magnetic layer 25 and the bias layer 26 are formed on said free magnetic layer 24 as shown in drawing 10 , it is desirable to form said non-magnetic layer 25 with nonmagnetic electrical conducting materials, such as Ta and Cu, in this invention, and it is desirable to form said bias layer 26 by permanent magnet film, such as CoPtCr and CoPt. Or said bias layer 26 may be formed by the switched connection film which consists of an antiferromagnetism layer and a soft magnetism layer.

[0175] In drawing 10 , it is desirable to give annealing in a magnetic field, before forming the bias layer 26, and to produce a switched connection field between the antiferromagnetism layer 21 and the magnetic layer 28 which constitutes the fixed magnetic layer 22. Magnetization immobilization of said fixed magnetic layer 22 is carried out in the height direction (the direction of illustration Y) by this. And although annealing in a magnetic field is again given when it is the switched connection film with which said bias layer 26 consists of an antiferromagnetism layer and a soft magnetism layer after forming said bias layer 26, the impression field at this time is smaller than the exchange anisotropy field of the antiferromagnetism layer 21, and, moreover, makes heat treatment temperature temperature lower than the blocking temperature of said antiferromagnetism layer 21. The soft magnetism layer which constitutes said bias layer 26 by annealing in this magnetic field is magnetized crosswise [ truck ]. Moreover, when said bias layer 26 is formed by the permanent magnet film, said bias layer 26 is magnetized crosswise [ truck ] (the direction of illustration X). Magnetization of said free magnetic layer 24 is arranged in the direction of illustration X because the vertical bias field from said soft magnetism layer and the bias layer 26 made from a permanent magnet flows into said free magnetic layer 24 by this.

[0176] Next, at the process shown in drawing 10 , a resist layer is formed in the top face of said protective layer 27, and it leaves the resist layer 60 of the configuration which shows this resist layer to drawing 10 by carrying out exposure development on said protective layer 27. Said resist layer 60 is a resist layer for lift off.

[0177] Next, the both sides of the multilayers 33 from the antiferromagnetism layer 21 which is not covered with said resist layer 60 to a protective layer 27 are deleted by the ion milling from arrow-head A (multilayers 33 are deleted along with the dotted-line part shown in drawing 10 ).

[0178] Next, at the process shown in drawing 11 , it applies to both-sides end-face 33a of said multilayers 33 from top-face 20a of the lower shielding layer 20 which extended crosswise [ truck ] (the direction of illustration X) further rather than both-sides end-face 33a of the truck cross direction (the direction of illustration X) of said multilayers 33, and spatter membrane formation of the insulating layer 34 by insulating materials, such as aluminum 2O3 and SiO2, is carried out.
[0179] Formation of said insulating layer 34 is performed from [ where the spatter include angle (include angle to a direction (illustration Z direction) perpendicular to lower shielding layer 20 front face) shown in drawing 11 becomes theta 1 ] arrow-head B. Said spatter include angle theta 1 is 30 degrees - 70 degrees.
[0180] The thickness of 34d of insulating layers which said insulating layer 34 becomes easy to adhere to both-sides end-face 33a of said multilayers 33, and adhered to both-sides end-face 33a of said multilayers 33 by making it large to include-angle extent which described above said spatter include angle theta 1 tends to become larger than the thickness of insulating-layer 34c adhering to top-face 20a of said lower shielding layer 20.
[0181] After applying to both-sides end-face 33a of said multilayers 33 from top-face 20a of said lower shielding layer 20 and forming an insulating layer 34, the side shielding layer 35 is formed on said insulating layer 34. Said side shielding layer 35 forms membranes by the spatter.
[0182] The magnetic material with which others and Co system amorphous material and an empirical formula consist of Fe-M-O (however, one sort or two sorts or more of elements with which Element M is chosen from Ti, Zr, Hf, Nb, Ta, Cr, Mo, Si, P, C, W, B, aluminum, Ga, germanium, and rare earth elements) as the quality of the material used as said side shielding layer 35 can be chosen. [ quality of the materials /, such as a NiFe alloy, / which are generally used as a shielding layer ] As a Co system amorphous material, it is Co-X (however, one sort or two sorts or more as which Element X is chosen from Zr, Nb, Hf, Ta, Ti, Mo, W, P, Si, and B), for example. The Fe-M-O ingredient serves as a phase organization with which the amorphous phase and the microcrystal phase of bcc-Fe mingled.
[0183] In addition, when forming said side shielding layer 35, it carries out all over a magnetic field. Uniaxial anisotropy can be given to said side shielding layer 35 crosswise [ truck ] (the direction of illustration X) by forming membranes among a magnetic field. Or although annealing in a magnetic field may be given and uniaxial anisotropy may be given to the side shielding layer 35, the heat treatment temperature at this time needs to be below the blocking temperature of said antiferromagnetism layer 21.
[0184] In addition, shielding ingredient layer 35b when forming insulating material layer 34a when forming an insulating layer 34 and the side shielding layer 35 has adhered to the top face of said resist layer 60.
[0185] Next, at the process shown in drawing 12 , spatter membrane formation of the insulating layer 36 which consists of insulating materials, such as aluminum 2O3 and SiO2, on said side shielding layer 35 is carried out. Formation of said insulating layer 36 is performed from [ where the spatter include angle (include angle to a direction (illustration Z direction) perpendicular to lower shielding layer 20 front face) shown in drawing 12 becomes theta 2 ] arrow-head C. Said spatter include angle theta 2 is 10 degrees - 50 degrees. It is completely [ in said insulating layer 36 ] a wrap about said side shielding layer 35 top.
[0186] Insulating material layer 36a when forming an insulating layer 36 according to the process shown in drawing 12 adheres on bias ingredient layer 35b on said resist layer 60. Then, said resist layer 60 is removed.
[0187] And it applies on said protective layer 27 from on said insulating layer 36, and plating formation of the up shielding layer 37 is carried out. In addition, since the layer of the same quality of the material which serves as a substrate first is beforehand attached by the spatter, formation of said up shielding layer 37 is energized in a substrate layer, and is performed by growing up the plating film of said up shielding layer 37.
[0188] Although the above is the manufacture approach of the magnetic sensing element shown in drawing 1 , the manufacture approach of the magnetic sensing element shown in drawing 2 does not form an insulating layer 34, but it is the production process shown in drawing 11 R> 1, and it should just form the side shielding layer 35 directly, applying it to both-sides end-face 33a of said multilayers 33 from top-face 20a of said lower shielding layer 20.
[0189] Moreover, what is necessary is for the manufacture approach of the magnetic sensing element shown in drawing 3 to be the production process shown in drawing 11 , and to make the spatter include angle theta 1 when forming an insulating layer 34 into the include angle more near an illustration Z direction, and just to make it said insulating layer 34 not adhere to both-sides end-face 33a of said multilayers 33.
[0190] Moreover, the manufacture approach of the magnetic sensing element shown in drawing 4 is the production process shown in drawing 11 , when forming the side shielding layer 45, continues and should just carry out spatter membrane formation of the 1st shielding layer 43 and the 2nd shielding layer 44.
[0191] Moreover, the manufacture approach of the magnetic sensing element shown in drawing 5 is the production process shown in drawing 11 , after it carries out spatter membrane formation of the insulating layer 34, forms the antiferromagnetism layer 40 on said insulating layer 34, and should just carry out spatter membrane formation of the soft magnetism layer 41 on said antiferromagnetism layer 40 further.

[0192] After forming the side shielding layer 42 which consists of said antiferromagnetism layer 40 and a soft magnetism layer 41, annealing in a magnetic field is given and a switched connection field is produced between said antiferromagnetism layers 40 and soft magnetism layers 41. In addition, even if it does not give annealing in a magnetic field, when a switched connection field arises, for example, when a switched connection field arises by membrane formation among a magnetic field like [ at the time of using FeMn, an IrMn alloy, etc. for the antiferromagnetism layer 40 ], there is no need for annealing.
[0193] When giving annealing in a magnetic field, it considers as a thing smaller than the switched connection field which generates the magnitude of the magnetic field between the antiferromagnetism layer 21 which constitutes multilayers 33, and the fixed magnetic layer 22, and heat treatment temperature is made below into the blocking temperature of said antiferromagnetism layer 21. Or when said bias layer 26 is the switched connection film of an antiferromagnetism layer and a soft magnetism layer, let magnitude of said magnetic field be a value smaller than the switched connection field of the antiferromagnetism layer of said bias layer 26. Moreover, heat treatment temperature is made below into the blocking temperature of the antiferromagnetism layer of said bias layer 26. However, especially when the direction of the switched connection field committed in the bias layer 26 is the same as the direction of a magnetic field at the time of annealing, there is no limit.
[0194] After forming an insulating layer 34, manufacture applying [ of the magnetic sensing element shown in drawing 6 ] it on both-sides end-face 33a of multilayers 33 from top-face 20a of said lower shielding layer 20 at the process shown in drawing 1111 , it carries out spatter membrane formation of the side shielding layer 35 on said insulating layer 34, and should just perform formation of the bias substrate layer 50 and the hard bias layer 51 on said side shielding layer 35 further.
[0195] After the manufacture approach of the magnetic sensing element shown in drawing 7 carries out spatter membrane formation of the lower gap layer 53 on said lower shielding layer 52 after carrying out plating formation of the lower shielding layer 52 first and forms a lower electrode layer 54 on said lower gap layer 53 further, it gives the process after drawing 10 and performs formation of the drawing 12 process next the up electrode layer 55, the up gap layer 56, and an up shielding layer 57 further.
[0196] Moreover, after the manufacture approach of the magnetic sensing element shown in drawing 8 gives the process first shown in drawing 10 , it is the process shown in drawing 11 , and forms an insulating layer 34. Then, the resist layer 60 shown in drawing 11 is removed, and spatter membrane formation of the shielding layer 70 which is applied to the top face of said multilayers 33 from the both sides of said multilayers 33 and by which the side shielding layer 35 and the up shielding layer 37 were made one at the process shown in drawing 13 is carried out from arrow-head D, for example.
[0197] Since said side shielding layer 35 and the up shielding layer 37 are formed by one by the manufacture approach of the magnetic sensing element shown in drawing 8 , compared with the case where said side shielding layer 35 and the up shielding layer 37 are formed separately, it is possible to easy-ize a production process very much.
[0198] According to the above manufacture approach, the side shielding layer 35 can be made to be able to counter easily and certainly the both sides of the truck cross direction of multilayers 33, effective regenerative-track broadening can be stopped, and the magnetic sensing element which can control generating of side leading can be manufactured.
[0199]
[Example] When changing the thickness to the truck cross direction of the insulating layer 34 which intervenes between both-sides end-face 33a of multilayers 33, and the side shielding layer 35 using the magnetic sensing element of the operation gestalt shown in drawing 1 , it investigated about the relation between the thickness of said insulating layer 34, and effective regenerative-track width of face (example).
[0200] Moreover, it measured about effective regenerative-track width of face using the thing of a gestalt in which the side shielding layer is not formed like the magnetic sensing element shown in drawing 16 as an example of a comparison.
[0201] The dimension and membrane structure which are common on the occasion of the experiment of the magnetic sensing element of an example and the example of a comparison first are explained.
[0202] The example and the example of a comparison set optical width-of-recording-track O-Tw to 0.15 micrometers. Moreover, the fixed magnetic layer 22 was made into the laminating ferry structure of CoFe/Ru/CoFe at the antiferromagnetism layer 21 using PtMn. Moreover, Cu was used for the non-magnetic material layer 23. Supply of the vertical bias field to the free magnetic layer 24 was performed using an in stack bias means by which the bias layer 26 of the permanent magnet film was formed through the non-magnetic layer 25 on said free magnetic layer 24 (see drawing 1).
[0203] In the experiment, the thickness to the truck cross direction of the insulating layer 34 currently formed by both-sides end-face 33a of the multilayers 33 of the magnetic sensing element of an example (those with a side shielding layer) was changed gradually, and the width method of the effective regenerative-track width of face at

that time was measured using the off-track profile method explained by drawing 15.

[0204] The relation between the thickness of said insulating layer 34 and effective regenerative-track width of face is shown in drawing 14. It turned out that said effective regenerative-track width of face becomes large, so that the thickness of said insulating layer 34 became large, as shown in drawing 14.

[0205] Moreover, in the magnetic sensing element of the example of a comparison, it turned out that a side shielding layer is not formed in both-sides end-face 33a of multilayers 33, but effective regenerative-track width of face spreads extremely that it is such a gestalt compared with an example.

[0206] As described above, optical width-of-recording-track O-Tw is 0.15 micrometers. Then, when the thickness of the insulating layer 34 in case the value which lengthened said optical width-of-recording-track O-Tw is set to 0.015 micrometers from effective regenerative-track width of face was investigated, the graph shown in drawing 14 showed that it was 0.06 micrometers or less. If thickness of said insulating layer 34 is set to 0.06 micrometers or less (the effective regenerative-track width of face at this time is set to 0.165 micrometers or less), the value which lengthened optical width-of-recording-track O-Tw from effective regenerative-track width of face will be made to 0.015 micrometers or less.

[0207] Moreover, when the thickness of the insulating layer 34 in case the value which lengthened said optical width-of-recording-track O-Tw is set to 0.01 micrometers from effective regenerative-track width of face was investigated, the graph shown in drawing 14 showed that it was 0.03 micrometers or less (the effective regenerative-track width of face at this time is set to 0.16 micrometers or less). If thickness of said insulating layer 34 is set to 0.03 micrometers or less, the value which lengthened optical width-of-recording-track O-Tw from effective regenerative-track width of face will be made to 0.01 micrometers or less.

[0208] It becomes possible to be able to set more preferably 0.06 micrometers or less of thickness to the truck cross direction of the insulating layer 34 formed in both-sides end-face 33a of said multilayers 33 as 0.03 micrometers or less in this invention, to be able to stop effective regenerative-track broadening effectively compared with the former by this, and to control generating of side leading appropriately by the above experiment.

[0209]

[Effect of the Invention] According to this invention explained to the detail above, it is the both sides of the truck cross direction of multilayers, and the side shielding layer is prepared between said lower shielding layer and the up shielding layer, this stops effective regenerative-track broadening also in narrow-track-izing, and it becomes possible to control generating of side leading compared with the former.

[0210] Moreover, in this invention, an insulating layer can be made to be able to intervene between said side shielding layers and multilayers, effective regenerative-track width of face can be more effectively brought close to the optical width of recording track by adjusting appropriately the thickness in the truck cross direction of this insulating layer, and it becomes possible to control generating of side leading more appropriately.

[0211] Moreover, in this invention, the current which flows to said multilayers from the up shielding layer which served as the electrode, and a lower shielding layer by forming with the magnetic material which has high resistivity compared with the free magnetic layer and fixed magnetic layer which constitute said multilayers for the resistivity of said side shielding layer is shunted toward said side shielding layer, and it cannot be and it becomes possible to manufacture a magnetic sensing element with a large playback output.

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[Translation done.]

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DRAWINGS

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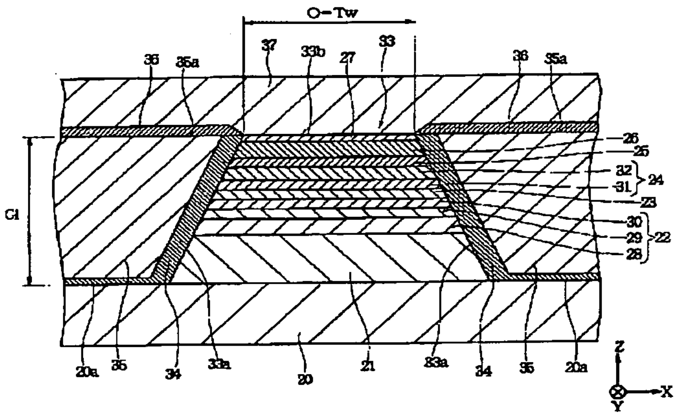
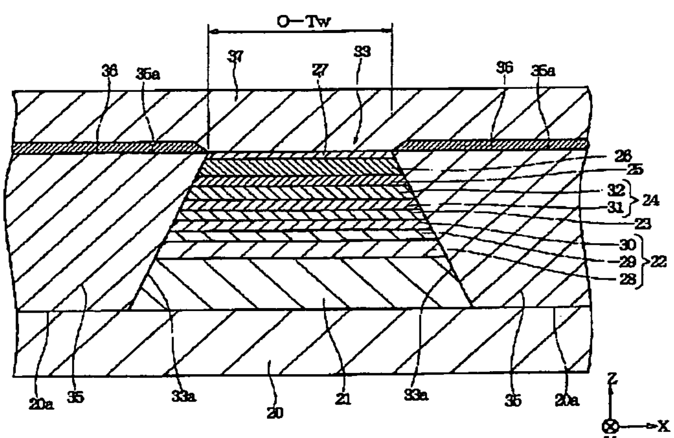
[Drawing 1]

図1



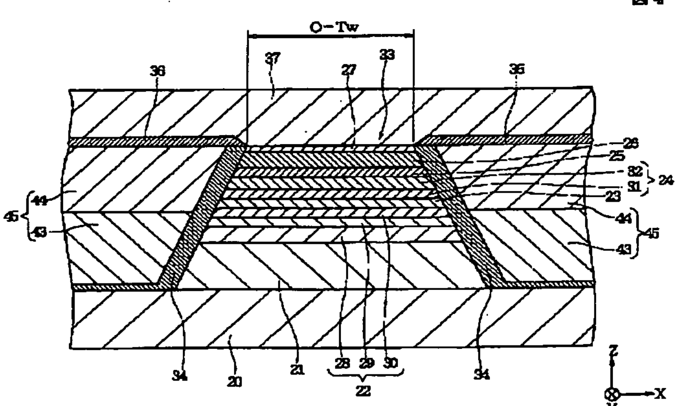

[Drawing 2]

図2



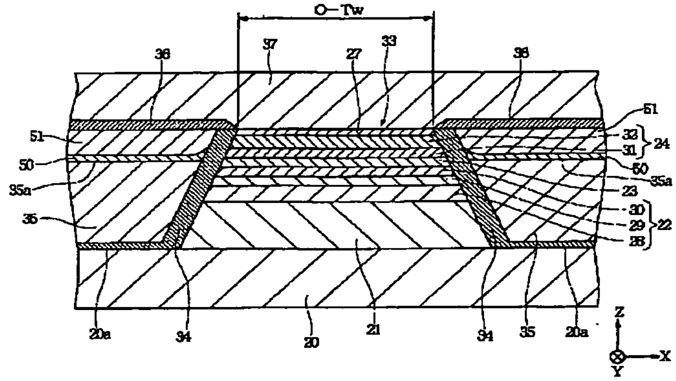

[Drawing 4]

図4



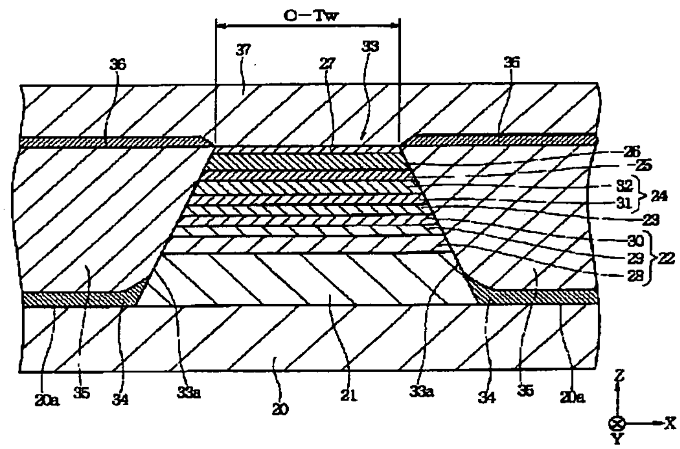
[Drawing 6]

図6



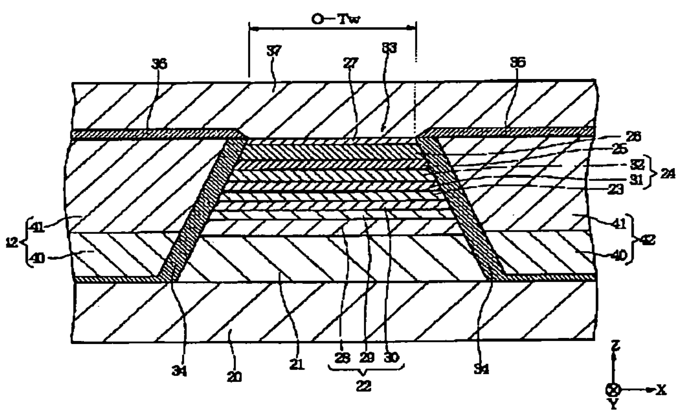
[Drawing 3]

図3



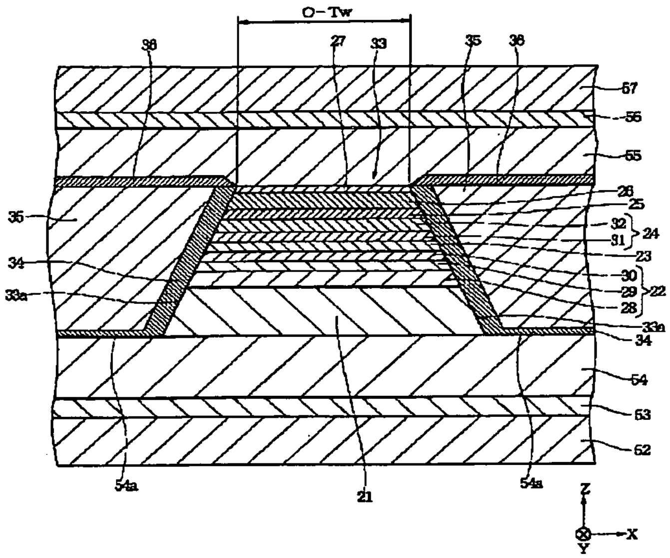
[Drawing 5]

図5



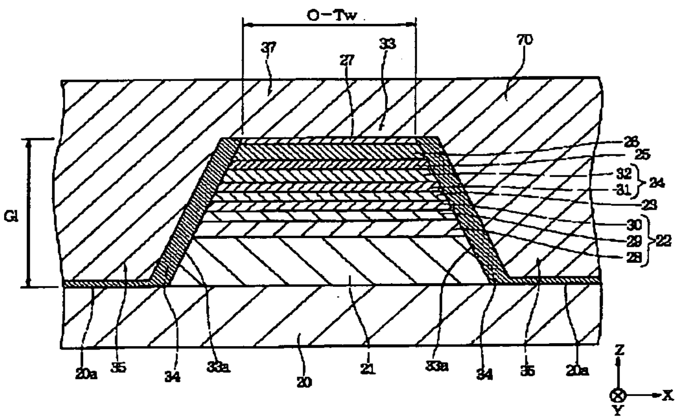
[Drawing 7]

図 7



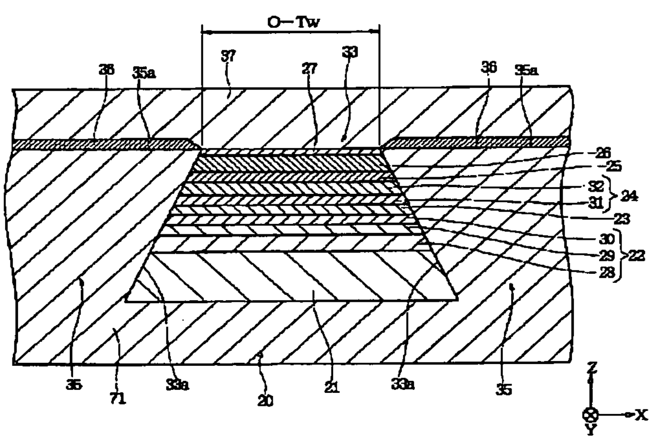

[Drawing 8]

図 8



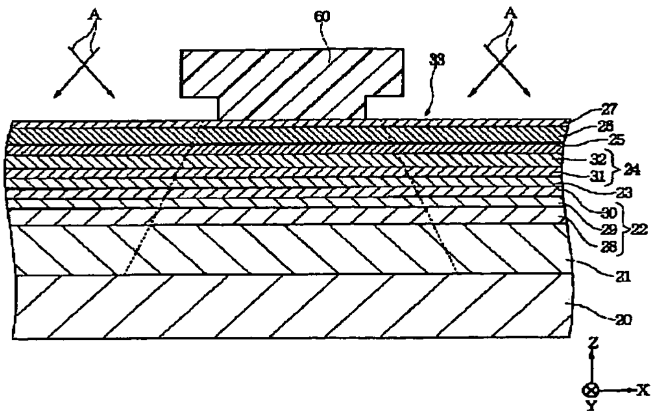

[Drawing 9]

図 9



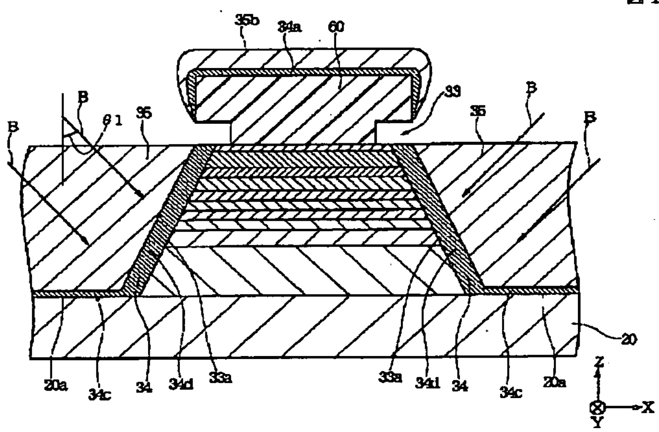

[Drawing 10]

図 10



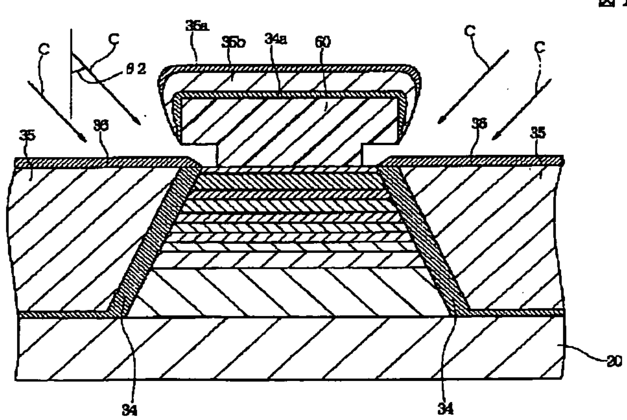

[Drawing 11]

図 11



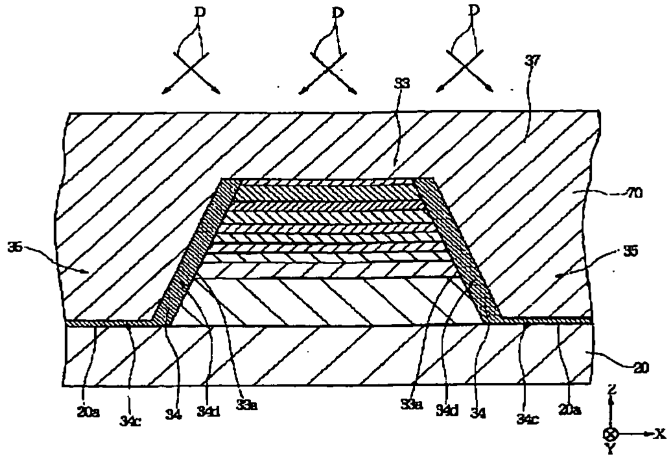

[Drawing 12]

図 12



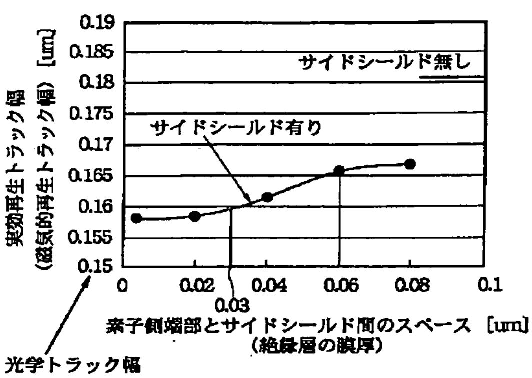

[Drawing 13]

図 13



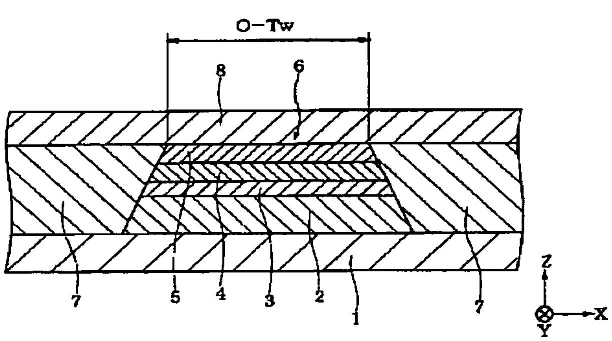

[Drawing 14]

図 14



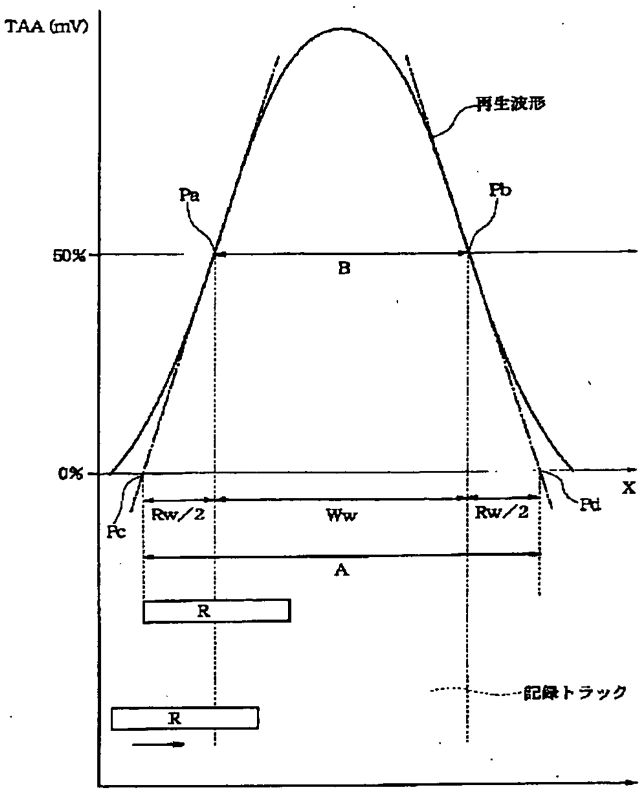

[Drawing 16]

図 16




[Drawing 15]

図 15




[Translation done.]